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THE AIR RESERVE FORCES IN THE TOTAL FORCE: VOLUME II. COST ANAL--ETC(U)

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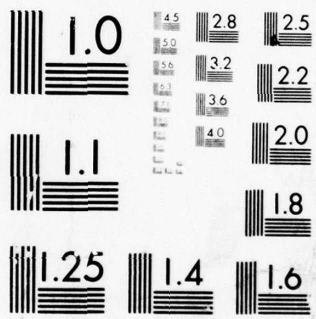

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The Air Reserve Forces in the Total Force: Vol. II Cost Analysis and Methodology

A. A. Barbour

A Project AIR FORCE report
prepared for the
United States Air Force

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The Air Reserve Forces in the Total Force: Vol. II Cost Analysis and Methodology

Volume II.

(10) A. A. Barbour

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PREFACE

In the fall of 1974, Rand began a study of total force options at the request of the Director of Plans, DCS/Plans and Operations, Headquarters United States Air Force. The study was to "evaluate varying active/reserve force mixes in terms of total costs, capabilities, and responsiveness to and availability for peacetime/wartime requirements." Subsequent interactions with the Air Staff resulted in a joint agreement to omit a comprehensive analysis of the total force mix; this was to be left to Air Force planners charged with this responsibility. Thus, a research program was designed with the following objectives:

1) To compare the costs and relative capabilities of active and reserve flying units and their supporting elements,
2) To examine organizational and managerial improvements and innovations applicable to total force integration; and
3) To develop a planning methodology for evaluating alternative active/reserve mixes and policies.

The primary vehicle for reporting on the research effort of the total force options study is the companion report R-1977/1-1-AF, *The Air Reserve Forces in the Total Force: Vol. I, Overview and Analytical Approach*. The present report focuses on cost aspects of the study.

An early conclusion of the research into total force costing problems was that current methods of estimating the costs of active and reserve flying units were not sufficiently alike to permit unbiased cost comparisons across active/reserve lines. The so-called "typical" active and reserve units used in USAF force structure projections and force costing exercises differed conceptually, and the cost factors for the Air Reserve Forces were incomplete. Thus an important part of this study involved the derivation of a costing methodology to put the active and the reserve squadrons on a more nearly equal footing.

During this research effort, the emerging cost concepts and some tentative active and reserve cost comparisons made using this approach

were circulated among interested members of the Air Staff and reserve organizations in printed and briefing form. In the ensuing exchange of ideas and viewpoints, a number of useful suggestions were received which were incorporated into the methodology.

To permit Air Force planning staffs to test the cost implications of total force mix alternatives, Rand's computerized force cost model (FORCE) was modified to model the unique attributes of the reserve forces. Concurrently, the necessary inputs for the reserve force elements were developed and added to the FORCE data base. When this work was completed, a series of example cost model computer runs was designed with the dual purpose of demonstrating the versatility and scope of the cost model, while also calculating estimates of the cost implications of some of the force options described in the main report of the study (R-1977/1-1-AF).

The data base is grounded in the May 1975 *USAF Force and Financial Program* as projected for *POM* 77-3, with costs in terms of 1976 dollars. Although the resultant projections are by now out of date, they are adequate for the purposes of this report, and the underlying data base forms a solid basis for subsequent data revisions.

The present volume is the final report of the cost analysis part of the Total Force Options study under Project AIR FORCE (formerly Project RAND) by The Rand Corporation. It is intended primarily for use by staff elements concerned with force structure planning and force development.

SUMMARY

This report addresses the cost analysis aspects of Rand's Total Force Options study. Our initial research revealed that existing methods for estimating the costs of active and Air Reserve Forces (ARF) were inconsistent: The support elements included in the active and ARF units were different, and the cost factors for the reserve forces omitted certain expenditures made on their behalf by the active establishment. Consequently, these diverse methods were not suitable for making cost comparisons bearing on active/ARF total force issues, a basic goal of the study.

Thus, a major undertaking of the Total Force Options study was the development of an ARF costing approach and a set of cost factors for reserve tactical systems that were consistent, conceptually, with active force practice, while retaining the ability to account for the essential characteristics that differentiate the ARF from the active establishment. The methodology that emerged was incorporated into Rand's computerized force cost model (FORCE) and it is reflected in the form of the cost model inputs that were derived for the FORCE data base.

Using this more consistent costing approach, which puts reserve units on a basis comparable to active units, some basic cost comparisons were made between identically equipped individual active and reserve squadrons using selected tactical airlift and fighter aircraft models that are common to both components.* The annual operating cost estimates for such reserve squadrons averaged about 30 percent less than their counterparts in the active forces--given the same UE aircraft strength and normal ARF operating levels. Again using individual squadron examples for clarity, it is shown that these costs are significantly affected by changes in the force beddown and activity levels (flying hours). With these basics established, the next part of the report deals

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*This does not necessarily imply that the active and ARF squadrons are equally capable. Issues of military capability are addressed in Sec. V of the companion report, *The Air Reserve Forces in the Total Force: Vol. I, Overview and Analytical Approach*, R-1977/1-1-AF, September 1977.

with total force issues and ARF policy options that affect economy of operation.

The use of the FORCE cost model in total force cost analysis is demonstrated by means of a varied series of examples that encompass: (1) a transfer of six squadrons of C-130s (96 aircraft) from the active inventory to the ARF, with four beddown variants to show the range of level-off annual savings they imply; (2) savings from a major reduction in strength of ARF combat support personnel; (3) a reduction in flying hours for squadrons equipped with obsolescent aircraft; (4) ARF grade relief to permit more prior-service applicants to be acquired to fill lower echelon jobs; and (5) a hybrid-associate, combined active/ARF aircrew, concept for 12 MAC C-130 squadrons.

On the basis of our brief experience with FORCE during this study, we believe that this cost model could prove to be a very useful tool for Air Force planning staffs responsible for force structure and policy analysis.

ACKNOWLEDGMENTS

Colonel James Reeves (AF/XOXFT) and Colonel James Cronin (AF/PRM) and members of their staffs provided Air Force views, advice, and guidance throughout the study. The necessary background information and data needed to derive the reserve inputs for the cost model were furnished by the comptroller, personnel, manpower, Technician, and training staffs of the Air National Guard and Air Force Reserve, and assistance in interpreting the financial data was furnished by the extremely capable Air Comptroller staff of the National Guard Bureau. Staff officers at MAC and TAC Headquarters gave helpful advice on earlier cost methodology papers.

Significant research contributions were made by Annette Bonner, who helped to derive the reserve manpower inputs for the cost model, and Robert Paulson, who designed and helped to interpret the illustrative cost model computer runs. Gary Massey and David Cates incorporated the proposed reserve routines into their FORCE cost model. Brent Bradley, Donald Palmer, Ron Hess, and Bernard Rostker reviewed the draft report and offered many useful suggestions to improve and clarify the presentation.

Although this costing effort could not have proceeded without the full support and cooperation of the above-named individuals and groups, the manner in which the data were used to develop the costing relationships and the interpretations given to the resultant cost comparisons are, of course, the sole responsibility of the author.

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I. INTRODUCTION

The major objectives of the Total Force Options study were (1) to accumulate relevant information leading to a comprehensive understanding of the military attributes and associated costs of active and Air Reserve Force (ARF)* flying units, (2) to develop improved methods for measuring the effects on cost and military capability of changes in the total force mix of active and ARF units, and (3) to estimate the effects on cost and capability of alternative ARF operational policies. This report focuses on the cost methodology and cost analysis objectives of the study.

Our investigation of the methods currently in use to estimate the costs of active and ARF flying units (for example, the *F&FP*[(1)] projections) revealed that they lacked the consistency in approach that is necessary to produce meaningful, unbiased cost comparisons across active/ARF lines. The organizational frameworks for costing the two kinds of forces were different, and the ARF cost factors were less comprehensive than those used to cost the active force units. Therefore, our initial cost analysis task was to develop a consistent and objective costing approach to be used for both the active and ARF units. This common methodology was patterned along the lines of active force costing practice, with adjustments where appropriate to reflect the unique characteristics of ARF units, such as the part-time nature of the ARF operation, and the cadre of civilians--most of them also doubling as reservist members of the units--who provide the day-to-day administrative and maintenance functions.

To provide Air Force planning staffs with a computerized cost model for estimating the cost implications of total force options, we incorporated ARF costing routines into Rand's force cost model (FORCE) and developed a comprehensive data base with the necessary ARF inputs. The resultant total force cost model and underlying cost approach are described briefly in Sec. II.

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*The ARF has two components: the Air National Guard (ANG) and the U.S. Air Force Reserve (USAFR).

To furnish some insights into active force and ARF costing relationships, some individual squadron system cost comparisons are given in Sec. III. They put the reserve squadrons on a consistent basis with active squadrons and show the magnitude of, and the reasons for, the cost differences between active and ARF squadrons equipped with the same aircraft. These basic cost estimates are then recalculated with different assumptions of beddown, UE (unit equipment) aircraft strength, and activity levels to reveal the relative importance of these "cost drivers" on the resultant cost estimates.

In Sec. IV, we demonstrate the use of the FORCE cost model in helping to analyze total force cost problems. The example cost model runs formed the basis for the cost estimates that appear in the main report of the study (R-1977/1-1-AF).[2] Finally, the conclusions are summarized in Sec. V.

A cursory description of the principal routines of the FORCE cost model is presented in the Appendix. Supporting documentation for the ARF cost factor derivation and a detailed description of the inputs needed for the cost model examples that are summarized in Sec. IV of this report are available to authorized Air Force personnel directly from The Rand Corporation.[3,4]

Readers who are unfamiliar with ARF operations and organization would benefit from reading R-1977/1-1-AF, especially Sec. II, before proceeding.

II. COST MODEL AND UNDERLYING COST METHODOLOGY

One of the primary objectives of the Total Force Options study was to develop a methodology for analyzing total force structure issues. This section describes the characteristics, underlying cost methodology, and data base of a Rand cost model that was modified as a part of this study to incorporate ARF costing routines. This revision resulted in a total force cost model that can estimate the cost implications of total force mix tradeoffs and of other force options that have a significant impact on the Air Force budget.

COST MODEL CHARACTERISTICS

Measuring the cost implications of force structure alternatives that involve a force as large and varied as the U.S. Air Force is made tractable by the use of computerized force cost models. It was clear from the outset of the Total Force Options study that a cost model would be needed to assist in the evaluation of force tradeoffs that encompassed not only the active forces but the reserve forces as well. Moreover, since our research objectives included an examination of operational and manning policies, it was desirable to have a cost model that could estimate the cost effects of changes in flying hours, crew ratios, and other important cost drivers. Fortunately, a computerized cost model (FORCE), developed at Rand just prior to the start of our study, had the desired basic analytic capabilities. It can:

- Estimate costs in a total force context, rather than use the individual squadron system cost approach.
- Estimate the cost of "quality" variations, e.g., crew ratio, UE, annual flying hours.
- Treat base operating support (BOS), training, and other non-organic support as separate elements, rather than as indirect costs of aircraft squadrons.
- Make long-range (15-year), time-phased, cost projections.*

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*Costs are shown in undiscounted, constant-year dollars.

- Display output in a form similar to that in the *F&FP*.

All that FORCE needed to perform *total* force tradeoffs were some additional routines to model the unique attributes of the ARF, and an expansion of the force element data base.

The new routines that were incorporated into the cost model accounted for ARF characteristics such as (1) pay according to the number of training man-days/drills in which the reservists participate, (2) the existence of a cadre of full-time civilian/Air Technicians who administer the reserve units and maintain their aircraft on a day-to-day basis in peacetime, and (3) the acquisition of new personnel who have already served in the active forces and who, therefore, do not require the costly training usually given to first-termers.

The cost model data base already contained detailed inputs for all of the *active* force elements, but data on the USAFR and ANG elements were limited to active duty liaison personnel and to the total costs shown for the ARF elements in the Air Force *F&FP*. Providing the necessary data inputs for the ARF components was an extensive job, almost doubling the size of the data base. This is because the number of planning elements (roughly comparable to the program elements of the *F&FP*) is determined by the *number* of different aircraft models rather than by the force size, and the ARF is characterized by its multiplicity of aircraft types.

COSTING APPROACH

Our first step was to develop a costing approach for the ARF units. Although there are some basic differences, the ARF costing approach that emerged is based, conceptually, on active force costing practice. The cost factors that were developed for the ARF include expenditures incurred by the active establishment on their behalf; for example, the training costs of reservists include the costs generated in Air Training Command (ATC) by the presence of reservist trainees. This is especially important in pilot training. Also, in the interest of consistency, the manpower and costs attributable to ARF flying units are estimated under the same ground rules as those used for active force units; that is,

only the "variable" (incremental) support that is generated by the force elements is included in their costs. This approach is quite different from the *POM** and *F&FP* projections for ARF units, which include the costs of *all* of the base operating support functions in with their ARF "typical" flying unit costs--including those support elements that appear to be predicated on Air-Force-wide post-mobilization requirements.† To include such support in the ARF unit costs while excluding all but variable support from the costs of active units would tend to bias the force mix tradeoff cost estimates. The support units deleted from the flying groups are included in the data base as separate elements, to facilitate an evaluation of their overall requirements in conjunction with their total costs.

The balance of this section presents a brief review of the modified FORCE cost model and, particularly, its supporting data base. The descriptions of the form and derivation of the various inputs--force structure, flying hours, manpower, and cost factors--will reveal the underlying costing methodology and will give the reader an appreciation of the cost model's scope and versatility in addressing problems that are central to force planning and policy analysis.‡

FORCE STRUCTURE

The base-line force structure is grounded in the 10-year projections that appear in the *F&FP* projected for *POM* 77-3, covering the years 1975 through 1984. As noted above, the data base that had been prepared for the FORCE cost model contained detailed inputs for all of the active forces, but the ARF was represented in "throughput" form, i.e., the planning element costs were taken from the above-cited *F&FP* and simply added into the appropriate grand totals that were printed by the model.

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*USAF Program Objectives Memorandum.

†See Ref. 2, Sec. VI.

‡Diagrams depicting the cost model's major routines, together with an explanatory text, are available in the Appendix, and a full description of the model is given in Ref. 5. The derivation of the base-line data base is described in detail in a separate, classified, appendix to this report (Ref. 3); it is available from Rand for the use of authorized Air Force personnel.

Table 1 shows the expanded list of ARF planning elements for which the required manpower, aircraft allotment, and other inputs were prepared to permit FORCE to model the Air Force's active/ARF total force. The USAFR planning elements appear first--flying elements, collocated unit support, and general support--followed by the corresponding ANG elements.

Air Reserve Force "typical" flying units in *POM* and *F&FP* projections include their entire base support structure, which is not consistent with the approach used for the active force flying units. In the active force planning elements, flying units comprise only the tactical squadron, a prorated share of wing headquarters, aircraft maintenance, munitions maintenance, and weapon system security. Their combat support, civil engineers, and other BOS activities appear, in aggregate, in separate BOS planning elements. The variable part of the BOS* is calculated by the cost model according to appropriate command estimating relationships, generally 15 to 20 percent of the base population. In the interest of comparability, the same general scheme was adopted for the reserve force structure, with some modification to reflect the unique reserve characteristics. For example, the manpower inputs for reserve planning elements of deployable aircraft squadrons include mobility support flights. These units provide the *wartime* base augmentation (variable BOS) for the mobilized and deployed reserve squadrons. Peacetime BOS for reserve units is provided by full-time civilians and Air Technicians† who are estimated by the cost model with the same method as BOS for the active force squadrons. Although we could have included the mobility support flight as a part of the BOS planning elements, it was considered more desirable to keep intact all of the deployable elements of the reserve flying units.

The reserve BOS units that are collocated with the flying units in peacetime but do not deploy with them when mobilized are allocated to

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*So-called "variable" BOS consists of functions that are sensitive to variations in base tenants (primarily personnel strength). The other BOS component, the "base opening package," comprises activities related to flight operations, base facilities support, and certain overhead functions.

†This is the ANG term. In the USAFR they are called Air Reserve Technicians.

Table 1

LISTING OF RESERVE PLANNING ELEMENTS
IN THE TOTAL FORCE DATA BASE

Air Force Reserve	Air National Guard
Flying Units	
EC-121 squadrons	F-101 squadrons
KC-135A squadrons	F-106 squadrons
F-105B squadrons (18 UE)	Follow-on interceptor squadrons
F-105D/F squadrons (24 UE)	B/EB-57 squadrons
F-105 (total)	F-4C interceptor squadron (Hawaii)
A-37B squadrons (18 UE)	F-4E interceptor squadron (Hawaii)
A-37B squadrons (24 UE)	F-4 interceptor squadrons (total)
A-37 squadrons (total)	KC-135 squadrons
A-10 squadrons	A-7 squadrons (18 UE)
F-4D squadrons	A-7 squadrons (24 UE)
F-4E squadrons	A-7 squadron (Kirtland Army support)
F-4 squadrons (total)	A-7 squadrons (18 UE) (Puerto Rico)
F-15 squadrons	A-7 squadrons (total)
F-16 squadrons	F-100 squadrons (24 UE)
F-111D squadrons	F-100 squadrons (18 UE)
AC-130 special operations forces squadrons	F-100 squadrons (total)
	F-105 squadrons (24 UE)
CH-3 special operations forces squadrons	F-105 squadrons (20 UE)
	F-105 squadrons (total)
Special operations forces squadrons (total)	A-37 squadrons (24 UE)
	A-7 combat crew training school
C-123 squadrons	F-100 combat crew training school
C-130A squadrons (8 UE)	F-4C/D combat crew training school
C-130B squadrons (8 UE)	F-105 combat crew training school
C-130B squadrons (16 UE)	TAC fighter training squadrons (total)
C-130 E squadrons (8 UE)	
C-130 E squadrons (16 UE)	F-4C squadrons
C-130 squadrons (total)	F-4D squadrons
C-7A squadrons	F-4E squadrons
C-141 squadrons (associate)	F-4 squadrons (total)
C-141 squadrons (associate) (Industrial Fund)	A-10 squadrons
	F-15 squadrons
C-9A squadrons (associate)	F-16 squadrons
C-9A squadrons (associate) (Industrial Fund)	F-111D squadrons
	RF-101 squadrons
C-5A squadrons (associate) (17 UE)	RF-4C squadrons
	Reconnaissance technical squadrons (1/RF wing)
C-5A squadrons (associate) (18 UE)	
	KC-97 squadrons
C-5A squadrons (associate) (total)	C-130A squadrons
	C-130B squadrons
C-5A squadrons (associate) (Industrial Fund)	C-130D squadrons
	C-130E squadrons (8 UE)
HC-130H AR/R squadrons	C-130E squadrons (16 UE)
HH-1H AR/R squadrons	C-130E squadron (Alaska)
CH-3B/C AR/R	C-130 squadrons (total)
Aero rescue/recovery (total)	C-7A squadrons
WC-130 squadrons	EC-121 squadrons
C-130 combat crew training school	C-130 ABCCC (TACS) squadron

Table 1--Continued

Air Force Reserve	Air National Guard
Flying Units--Continued	
	O-2 squadrons (TACS) Tactical communications units (tactical air control) Direct air support control squadrons Tactical air control squadrons (total) HC-130 AR/R squadrons HH-3 AR/R squadrons Aero rescue/recovery (total)
Depot-Level Maintenance	
Logistic Support	Depot Maintenance
Unit Support	
Air Force Communications Service communications flights Aerial port flights Medical (tactical hospitals/clinics) Combat support squadrons Security police flights	Air Force Communications Service communications flights Aerial port flights Supply squadrons Medical (tactical hospitals/clinics) Aeromedical evacuation units Combat support squadrons Civil engineering flights
General Support	
Aerial port squadrons Maintenance squadron (mobile) Supply squadron (mobile) Mobile maintenance & supply squadrons (total) Depot augmentation squadrons Medical service units Aeromedical evacuation units Mobilization assignees Civil engineering squadrons (heavy repair) Civil engineering flights Command (miscellaneous) Command (USAFR officers on active duty) Command (total)	Air Control & Warning units (Puerto Rico and Hawaii) Communications units (mobile communications) Communications units (electronic installation) Communications units (other) Communications units (total) Weather units Civil engineering (heavy) Command (state headquarters) Command (Air Force bands) Command (other) Command (including reserve officers on active duty)(total)
Base Operating Support	
BOS (USAFR bases) BOS (commercial airports) BOS (Air Force bases) BOS (Air National Guard bases) BOS (Navy bases) BOS (total)	BOS (commercial airports) BOS (Air National Guard bases) BOS (Air Force bases) BOS (USAFR bases) BOS (Navy bases) BOS (total)
Reservist Trainees	
Recruit training Technical training Undergraduate pilot training Undergraduate Navigator/Electronics Warfare Officer training USAFR training (total)	Recruit training Technical training Undergraduate pilot training Undergraduate Navigator/Electronics Warfare Officer training Air National Guard training (total)

separate planning elements that were established for each of the major support activities, e.g., combat support, civil engineering, and communications. Support units that are organized in peacetime as part of the flying units are shown in the Table 1 listing as "unit support." Besides the unit support elements, there are a number of support functions that are organized independently. These latter "general support" elements include such activities as mobile maintenance and supply squadrons, medical service units, and civil engineering heavy repair squadrons. Both unit and general support planning elements are intended to be justified on their own merits, not as dependent variables of the reserve flying unit force structure.

It will be noted that base operating support, training, and depot maintenance are treated as separate elements in this cost model, rather than as "indirect costs" of the flying units. Depot maintenance, for instance, is computed for each aircraft planning element on the basis of cost per UE aircraft and cost-per-flying-hour factors for the given aircraft types. The resultant depot costs, however, are shown only as "below-the-line" informational costs at the aircraft planning element level; the cumulative total depot maintenance costs appear in separate depot maintenance elements--as they do in the *F&FP*. Base operating support and training similarly are derived on the basis of overall, total force considerations.

Several aircraft types are included in our force structure that are not now programmed for the ARF, e.g., F-111s and F-15s. Data inputs were prepared for each of these aircraft types to permit the planner to test the cost implications of such transfers.

MANPOWER

The cost model permits separate tabulations for as many as 24 different personnel types, the choice being at the discretion of the analyst. The following personnel types were selected for the present data base because of their differences in Air Force component affiliation, pay levels, and training requirements:

Active Duty/USAFR/ANG

Officers	Airmen	Civilians/ Technicians
Pilots	Aircrew	Aircraft maintenance
Navigators/ Electronics Warfare Officers	Aircraft maintenance[a]	Other
Other	Other	

[a]Included in "Other Airmen" for USAFR and ANG units.

Manpower can be input as number per UE aircraft, number per squadron, by crew ratio and crew composition, by maintenance-manhours-per-flying-hour factors, and, in certain support planning elements, as a function of tabulated total manpower. Some personnel types have their manpower input by a combination of these methods. For example, the "other" (i.e., non-aircrew) ARF airmen are input both as number per squadron and number per UE.

The manpower estimates for active force flying units are based on strength information in the *USAF Cost and Planning Factors* document, AFR 173-10.(6) Data on the general support element personnel were obtained from such diverse sources as the USAF's *Program Guidance*,(7) *Manpower and Organization*,(8) the *F&FP*, and the *USAF Statistical Digest*.(9)

The basic sources used for reserve military manning were the Air Force Reserve *Manpower Authorization*(10) and the Air National Guard *Status of Units* report.(11) The manpower figures in these ARF documents are in terms of *authorized*, i.e., desired, strength. Although the programmed reservist manning is 5 to 10 percent lower overall than the authorized strength, the impact on individual units is uneven: Some units are over-manned, some are under-manned, and surprisingly, in some groups the support organizations have a higher manning level than the tactical elements. In view of these disparities, plus the possibility, mentioned in the companion report (R-1977/1-1-AF), of improving the manning levels by decoupling and relocating the support functions that are not required by the flying units, it was decided to use the authorized manning for the cost model inputs. Since reservist-generated costs

account for only about 20 percent of an ARF flying unit's costs in any case, this simplified approach adds less than 2 percent to the overall totals, which is well within the margin of error of the estimates. The overall USAFR and ANG manning levels may be adjusted by means of two dummy planning elements entitled "manning level adjustments." Although the manning strength reports we used are now out of date, the more recent USAFR reports that we have seen indicate that the manning of particular units since that time has not changed enough to affect the costs to any appreciable extent.

The USAFR manpower document, cited above, gave civilian *total* manning per group and per base. Information on the distribution, by activity or function, of the Air Reserve Technicians and civilians was obtained from a set of civilian unit detail listings from Air Force Reserve Headquarters.(12)

The source of strength data on ANG Air Technicians was a detailed computer printout provided privately to Rand by the National Guard Bureau's Office of Technician Personnel.

The data source used for the manpower inputs of *active* flying units, AFR 173-10, provided the desired breakdowns: The manning strengths for the flying unit planning elements were distributed by crew, squadron overhead plus a prorata share of the wing and group headquarters, aircraft maintenance, munitions maintenance,* and weapon system security,† and the various BOS functions were combined into a separate BOS category. Moreover, AFR 173-10 furnished BOS strength data broken down by the fixed base opening package and the variable portion--separate variable BOS factors being available for the various commands. As these cost model inputs for active force planning elements are based on official USAF planning factors, they will not be further discussed here.

With regard to the reserve units, AFR 173-10 does not contain the relevant reserve strength data and, further, since our manning source

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*The ARF consolidated aircraft maintenance squadrons include munitions maintenance.

†Some of the active duty typical squadron strength figures in AFR 173-10 were out of date. Manpower experts in USAF's Manpower and Organization Directorate (PRM) provided guidance in revising these manpower strengths to reflect the FY 1976 program assumptions.

documents and the *F&FP* all display the reserve flying units as complete entities comprising both the tactical and support elements, it was necessary for us to redistribute the reservist personnel into categories that were consistent with the active duty elements.*

We also performed a simple regression analysis of reservist base population versus the number of BOS civilian/Air Technicians to derive the BOS estimating relationships required by the cost model. The results of the ANG analysis indicate a weak scalar relationship of the form

$$\text{BOS Technicians} = 40 + (0.034 \times \text{reservist population}).$$

Since the USAFR regression analysis was obscured by the fact that most of their units are located on large active Air Force installations that provide a substantial part of their BOS requirements as a host responsibility, we used the ANG variable BOS factor for the USAFR units as well. Given the relative unimportance of reserve variable BOS, this estimating relationship appears quite acceptable for our requirements.†

School training encompasses the training of replacements and personnel added to total strength, as well as advanced technical and professional training for personnel already on-board. To compute the trainee load, the cost model requires inputs of turnover rates, course durations, and in the case of the ARF, the expected proportions of nonprior-service personnel among the new acquisitions. The nonprior-service fractions reduce the calculated training requirements to account for the presence of already-trained prior-service personnel among the reservist enlistees. The above factors are used in conjunction with the manpower totals computed by the cost model to estimate the time-phased requirements for trained personnel, the amount of training man-days involved, and at a later point, the requirements for training staff and other resources that are implied by the trainee workload.

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*The procedures that were followed and the resultant manpower strength breakdowns are given in R-1977/3-AF, a technical appendix to this report (Ref. 3).

†The BOS services provided to ARF tenants by non-reserve organizations for a fee are included in the O&M cost factors, discussed below.

The factors for computing advanced training at technical schools for each component--active force, USAFR, and ANG--are simply the ratios between the number of officers and airmen of each component programmed for advanced technical training and the corresponding total number of officers and airmen in the force.

After the model has computed the student man-years, staff/student ratios (the same for active and reserve trainees) are employed to establish the ATC manpower generated by the training load.

We excluded the so-called "school" training not accomplished at ATC schools from the cost model training inputs because they would invalidate the subsequent school staff computations. Aircrew "school" training performed at the home station or CCTSs utilizes flying hours that are programmed as part of the regular flying-hour allocation for the individual squadrons; no additional flying costs are entailed in this crew training activity above that already programmed for the unit. Moreover, the instructor pilots are members of the reserve tactical organizations. Thus, only the man-day costs of the trainees impact on the budget. To include such training in the cost model training procedure would result in generating school staffs and flying-hour costs that are already included in the costs of operating the individual flying squadrons. For these reasons we excluded from the school training man-day totals that portion designated as "refresher," "checkout," or "air qualification" training. These man-days were not left out of the data base, however; they were allocated in the same manner as special training to the annual man-day tabulations that underlie the personnel cost computations. These man-day calculations will be described later, in the personnel cost section.

FLYING HOURS

Peacetime flying hours are an important costing element because they determine the annual expenditures on POL, base maintenance, a large part of the depot maintenance, replenishment spares, and base maintenance material.

The primary source of flying-hour data was PA 77-3,[13] which corresponded with our *F&FP* source. However, the PA gives only *total* flying hours, by aircraft type, for the ANG. As a result, the necessary

inputs for that component's flying units were derived on the basis of the ANG's complex flying-hour estimation model that was furnished to Rand by the National Guard Bureau.

The FORCE cost model accepts flying-hour data either as annual flying hours per UE aircraft or as annual flying hours per crew, to which (in the latter case) is added the annual flying hours of the overhead personnel. For example, in the case of an ANG C-130E squadron, the total number of crews (32) determined on the basis of squadron UE (16) and the crew ratio (2.0) is multiplied by the flying hours per crew (162)* to yield the total annual flying hours for the line crews (5184). The 11 overhead crews† add another 1425 flying hours, resulting in a squadron total of 6609 flying hours per year.

COST FACTORS

Annual operating and maintenance costs are calculated in the model generally by means of cost factors. Costs related to personnel strength include pay and allowances, permanent change of station travel, and some miscellaneous costs. Because of significant cost differences, separate factors were developed for active and ARF officers, airmen, and civilians, with a further differentiation of people on flying status. Aircraft-related cost factors have been developed that vary with number of UE aircraft or annual flying hours per squadron. The aircraft-related factors vary for specific types and models of aircraft.

Aircraft-Related Cost Factors

As noted above, a number of operating costs are computed on the basis of an annual cost per UE aircraft or as a cost per flying hour. For aircraft common to the active and reserve forces the same aircraft factors were used. Therefore, these costs vary only with differences in UE or in flying hours. However, in the course of validating our

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*ANG estimates reduce the authorized 180 flying hours per line crew by a 10 percent "unavailability" factor.

†Including squadron headquarters and a prorata share of group and wing headquarters.

inputs to the FORCE cost model we discovered that the grand totals of certain categories of ANG and USAFR support costs, derived with the *POM* cost factors(14) for reserve aircraft, exceeded the Air Force *F&FP* projections of these expenditures by significant amounts--more than 25 percent in the case of ANG depot maintenance. This led to the discovery that the ANG, while regarding the *POM* cost model factors as "correct," in the sense of representing full support, in fact programs these support costs at lower rates in the annual budget projections in the expectation that the higher amounts implied by these factors would not be funded.

We were unable to judge whether the somewhat lower support implied by the ANG factors would significantly reduce the overall military capability or readiness of these older ARF squadrons. In any event, it would appear to be more consistent with the principles of equal treatment implied by the total force concept to assume that any *first-line* aircraft (e.g., A-7s, C-130Es) transferred to the ARF would continue to have the same level of support as those remaining in the active force. On this basis, the aircraft-related cost factors used for first-line aircraft in our cost analyses are those given in AFR 173-10 and the *POM* cost factor document, whereas for older aircraft--F-100s, A-37s, etc.--we use the ANG factors.

Table 2 shows the set of factors that were used to estimate the aircraft-related costs of C-130E aircraft squadrons. Similar factors are included in the FORCE data base for all of the mission aircraft in the active and reserve inventories.

Personnel-Related Costs

Costs that are estimated as a function of personnel strength include pay and allowances and minor costs such as travel, per diem, clothing allowances, and miscellaneous operations and maintenance (O&M). Table 3 displays average annual (1976) personnel costs for active duty and reserve personnel. Actually, although the costs of active duty personnel are input in this annual cost form in the FORCE cost model, the reserve factors reflect one of the characteristics that differentiate reservists from their counterparts in the active forces; namely,

Table 2

AIRCRAFT-RELATED COST FACTORS FOR C-130E AIRCRAFT UNITS

(1976 dollars)

Cost Factor	Annual Cost per UE Aircraft	Cost per Flying Hour
Procurement		
Aircraft modifications	9,039	
Common support equipment	6,011	
Replenishment spares		63
Total procurement	15,050	63
Operations & maintenance		
POL		345
Depot maintenance	86,555	129
System/general support material		77
Total O&M	86,555	551
Grand total	101,605	614

Table 3

PERSONNEL-RELATED ANNUAL COST FACTORS

(1976 dollars)

Cost Factor	Officers		Airmen	
	Rated	Other	Flying Status	Other
Active duty personnel (CONUS)[a]				
Basic	19,195	19,195	8,998	8,998
Flight pay	2,361		1,166	
Permanent change of station travel	846	846	402	402
Medical	160	160	160	160
Total personnel costs	22,562	20,201	10,726	9,560
Miscellaneous O&M	790	790	790	790
ANG personnel[b]				
Total personnel costs	6,500	3,800	3,000	1,500
Miscellaneous O&M[c]	710	710	710	710

SOURCE: Ref. 6, Tables 22, 27a, and BACE model (Attachment 50).

[a]Continental United States.

[b]USAFR personnel costs approximate those of the ANG.

[c]See Table 7, p. 22. The comparable miscellaneous O&M factor for the USAFR is $480/reservist.

reservists are paid for time worked rather than a fixed amount. To model this, the ARF personnel cost inputs are primarily in the form of cost-per-day factors, which are multiplied by (variable) average-number-of-days inputs to arrive at the annual total cost. Provision is also made for estimating the minor recurring costs as an annual-cost-per-man input. (This latter input has been found to be useful for "fine tuning" the personnel cost inputs during the factor validation process.) The individual factors and their derivation are given in Ref. 3.

The basic ARF daily pay factors comprise basic pay, flight pay, and a separate cost factor to cover the additional costs associated with training performed away from the home station, e.g., travel, per diem. Daily pay for reservists is defined as 1/30 of the monthly pay of active duty personnel of comparable rank.[*] It is earned for each authorized man-day or unit training assembly (UTA) drill that the reservists attend. Drills may be as short as four hours and it is the practice for a reservist to earn the equivalent of four day's pay for each drill weekend.

These cost factors and the man-day averages were estimated on the basis of daily cost and man-day information provided in the FY 1976 Air Force budget justifications[†] and supporting exhibits. Table 4 summarizes the ANG personnel budget, showing the breakouts of man-days and costs budgeted for officers and airmen, by major activity. Similar information is available for the USAFR.

The typical sets of man-day factors that are derived separately for the ANG and USAFR are the sum of the Group A[‡] UTA drills (nominally 48), the two-week annual tour of active duty training, additional flying training periods for certain personnel on flying status, plus portions of the special training and school training man-days.[**]

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[*] Reference 15, Sec. C, paragraphs 80141 and 80142.

[†] Reference 16, USAFR and ANG personnel sections.

[‡] The Group A category comprises 48 drill reservists who are members of units. See Ref. 2, Sec. II.

[**] The significantly greater number of paid man-days authorized for reservists on flying status is a primary reason for the personnel cost disparities that are indicated in Table 3 for reservists.

Table 4

ANG PERSONNEL BUDGET, FY 1976
(Costs in $ millions)

Budget Item	Officers		Airmen		Cost for Total Military
	Man-days	Total Cost	Man-days	Total Cost	
Group A					
UTA (drills)	556,416	27.3	3,780,480	72.4	
15-day active duty	172,560	11.4[a]	1,666,280	33.3[a]	
Additional flying training periods	152,352	8.2	39,744	1.1	
Miscellaneous expenditures	4,476	0.8[b]	49,368	7.0[c]	
Total Group A	885,804	47.7	5,535,872	113.8	161.5
Special training					
Recurring activities	147,765	10.8	126,748	5.0	
Conversion/recruiting	23,152	1.8	108,808	3.6	
Total special training	170,917	12.6	235,556	8.6	21.2
Recruit training (Group F)	--	--	780,160	14.4	14.4
School training					
Replacement/advanced training					
Trainee pay					
Refresher/checkout[d]	70,806	2.9	48,500	1.3	
Other	67,304	2.8	47,131	1.2	
Total replacement training		5.7		2.5	
Conversion	29,596	1.2	32,263	0.8	
Travel, subsistence, clothing	--	1.2	--	1.2	
Total school training	167,706	8.1	127,894	4.5	12.6
Administration and support					
Benefits	--	0.2	--	0.3	
Officers on active duty		3.2		--	
Total administration/support		3.4		0.3	3.7
Grand total cost		71.8		141.6	213.4

SOURCE: Ref. 16, ANG personnel section.

[a]Includes travel.

[b]Includes civil disturbance training, administration, clothing, and reimbursable subsistence.

[c]Includes civil disturbance training, clothing, and subsistence.

[d]Performed at local base or combat crew training school.

The special training allocation to the average man-day factors excludes the one-time "investment" conversion man-days and any special training that can be identified with specific missions, such as the air defense alert. For planning elements involved in these latter operations that receive an unusual allotment of man-days, the cost model permits the input of tailored man-day factors.

As was explained in the manpower section, the school training routines in FORCE are limited to ATC training; therefore, the man-days devoted to school training activities that are performed at the home station or at a combat crew training school are prorated among reservists as a part of the overall man-day factor.

It should be pointed out that although the man-day distributions between fliers and non-fliers could be identified in the budget justifications document for the Group A activities, the special training and school refresher/checkout training allocations are judgmental, because the information needed to effect the split is given only for the category totals. Although more complete information could result in somewhat improved man-day factors, the amount of error that may be introduced by distribution uncertainty in these two categories is felt to be minimal in the total cost context. Even in the case of support planning elements, where personnel costs predominate, the use of the FORCE model factors is preferable to using overall personnel cost averages, which are heavily weighted by the inclusion of aircrew personnel costs.

School training is a more important cost consideration in the active forces than in the ARF because a significant portion of ANG and USAFR recruits already have had formal initial training during a prior tour of military service. Besides the refresher/checkout training mentioned above, the one-time conversion training also was deleted from ARF school costs before deriving the FORCE model cost and man-day training factors.*

Trainee pay is estimated by multiplying the trainee load, estimated automatically by the model, with appropriate pay factors. Following Air Force budgeting procedures, the model properly allocates ARF trainee pay (plus travel, per diem, and other trainee costs estimated with per capita training factors) to the reserve mission cost totals.† The model then computes the other school costs, using the same routines as those designed for the active forces.

Table 5 approximates the average annual costs that are computed in the model to represent the training of active duty and reservist personnel replacements--the new acquisitions needed to offset personnel

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*It is input in the "conversion" dummy planning elements.

†FORCE missions correspond to *F&FP* programs.

Table 5

ANNUAL PRORATA REPLACEMENT TRAINING COSTS[a]
(1976 dollars)

Trainee Type	Aircrew		Other
	Pilots	Other	
Active duty personnel			
Officers	7,300	3,800	3,300
Airmen		1,300	1,300
ANG personnel[b]			
Officers	3,000	1,200	300
Airmen		500	500

[a]Estimated steady-state total annual training costs for each personnel type divided by the number of such personnel in the force structure.

[b]USAFR training costs are similar to those of the ANG.

turnover. The lower reservist factors stem from lower turnover rates and new personnel acquisitions that include large numbers of prior-service personnel.

Civilian and Miscellaneous O&M Cost Factors

Table 6 lists the average annual cost factors that are used in the FORCE model for costing Air Technicians and other civilian employees of the Air Force. The source of the cost data for civilians assigned to the active forces was the *POM* cost factors document.(14) They are weighted averages of general schedule, Wage Board, and direct-hire basic pay plus fringe benefits, such as retirement contributions, health and life insurance benefits, and the other miscellaneous employer costs including workmen's compensation and unemployment insurance. For the ARF, we used the O&M volume of the FY 1976 Air Force budget justifications.(17)

Table 6

CIVILIAN/AIR TECHNICIAN ANNUAL COST FACTORS
(1976 dollars)

Active Force Civilians	
SAC	13,450
ADCOM	14,427
AAC	19,560
TAC	13,401
PAF	8,153
USAFE	11,163
MAC	13,641
AFLC	15,026
ATC	13,695
HQC	14,230
Other	14,036
ARF Air Technicians/Civilians	
Aircraft maintenance	15,000
BOS	14,340[a]
Other	20,250

[a]ARF civilians in BOS activities are costed with the pay factor of the host when tenanted on active Air Force bases.

Rather than use a single average cost factor for all Air Technicians and civilians, we developed first-cut factors for the three primary functional categories--aircraft maintenance, BOS, and "other"*--as indicated in Table 6 on the basis of financial and civilian manning data obtained during our field trips to ARF bases and Air Force Reserve Headquarters.

Tables 7 and 8 show the allocation of the FY 1976 ANG and USAFR O&M budgets, respectively, and the derivation of the basic Technician/civilian and miscellaneous O&M cost factors. (The latter factors are included in the list of reservist personnel cost factors in Table 3.)

ARF COST FACTOR VALIDATION

To fine tune and to validate the individual ARF cost factors, we

*Command, operations, and miscellaneous support activities other than BOS.

Table 7

DISTRIBUTION OF ANG O&M COSTS, FY 1976, AND DERIVATION OF ANG O&M COST FACTORS

($ millions)

Cost Factor	Budget Total	Civilians		"Per Capita" Miscellaneous				Aircraft Factors	BOS Throughput
		Air Technicians	BOS	Medi-cal	Miscel-laneous	BOS	Total Miscel-laneous		
P-440 training support									
Air Technicians	345.6	345.6							
Other civilians	13.4		13.4						
Service contracts	32.3					32.3	32.3		
Travel/per diem: school	0.6	0.6							
Other travel/per diem	5.8	5.8							
Transportation	5.6				5.6		5.6		
Automatic data processing rental	4.6					4.6	4.6		
Other equipment rental	0.6					0.6	0.6		
Communications services	2.0					2.0	2.0		
Other services	7.5				7.5		7.5		
Supplies and materials	44.7							44.7	
Equipment	4.2							4.2	
Recruiting	1.7				1.7		1.7		
Minor construction	9.9					9.9	9.9		
Total P-440		352.0	13.4		14.8	49.4	64.2	48.9	
P-470 medical	0.7			0.7			0.7		
Total P-440/470	479.2	352.0	13.4	0.7	14.8	49.4	64.9	48.9	
P-410 aircraft operations	152.7				1.3[a]		1.3[a]	148.4	3.0[b]
P-430 logistics support	88.3							88.3	
P-480 service-wide support	3.3	3.3							
Grand total	723.5	355.3	13.4	0.7	16.1	49.4	66.2	285.6	3.0
Per capita factors:									
÷ 22,160 Air Technicians ($)		16,033							
÷ 938 other civilians ($)			14,341						
÷ 92,924 reservists ($)							710		

SOURCE: Ref. 17, pp. 209, 216, 225, 235.

[a]Non-aircraft POL.

[b]Base support aircraft.

Table 8

DISTRIBUTION OF USAFR O&M COSTS, FY 1976, AND DERIVATION OF USAFR O&M COST FACTORS

($ millions)

Cost Factor	Mission	Command Support	ARPC[a]	Other BOS	Medi-cal	Total	Cost Factor Basis: Air Technicians/ Civilians	Cost Factor Basis: Miscel-laneous O&M	Cost Factor Basis: Aircraft Factors	Cost Factor Basis: C-5/C-141 Through-put
Civilian personnel	128.6	13.0	8.0	26.6	0.1	176.3	176.3			
(manpower)	(8481)	(719)	(700)	(1702)	(7)	(11,609)				
Travel/per diem	2.1	1.2	0.1	0.3	--	3.7	3.7			
Transportation	1.2	--	--	0.9	--	2.1	--	2.1		
Rents, communications, utilities	1.4	0.8	1.3	3.4	--	6.9	--	6.9		
Printing, reproduction	0.1	0.1	--	--	--	0.2	--	0.2		
Other services	47.5	1.4	0.1	6.3	--	55.3	--	10.5	35.8[b]	9.0[b]
Supplies and materials	13.7	0.5	0.2	6.0	0.2	20.6	--	--	20.6	--
Equipment	1.7	0.1	0.1	0.5	--	2.4	--	--	2.4	--
Total	196.3	17.1	9.8	44.0	0.3	267.5	180.0	19.7	67.8	
POL[c]	39.2					39.2		0.6[d]	38.6	
Depot maintenance[c]	37.1					37.1			37.1	
Total O&M	272.6	17.1	9.8	44.0	0.3	343.8	180.0	20.3	134.5	9.0
Per capita factors:										
÷ 11,609 Air Technicians, civilians ($)							15,505			
÷ 42,566 reservists ($)								477		

SOURCE: Ref. 16, pp. 185-206.

[a] Air Reserve Personnel Center.

[b] C-141 = $24.1 million; C-9 = $0.7 million; C-5 = $20.0 million.

[c] POL, depot maintenance, and other O&M expense of non-revenue training flights of associate squadrons are included in "other services."

[d] Estimated on basis of ANG per capita cost.

ran the total base-line case on the computer and compared the ARF cost element grand totals against the corresponding totals shown in the *F&FP*. The aggregative cost elements used in the *F&FP* for the ANG, and the industrial funding of a large fraction of the costs generated by the USAFR's associate airlift squadrons made it difficult to verify some of the individual O&M cost elements. Overall, however, the factor-derived estimates are very close to the budget projections.

The cost model's active duty and reserve military personnel total costs are within 1 percent of the *F&FP* totals.* Our estimate of USAFR O&M costs are about 5 percent low, whereas the ANG year-by-year O&M estimates straddle the *F&FP* totals: 1 percent low in FY 1977 and 1 percent high in FY 1981. Differences in the totals for particular cost elements are small and offsetting. Spot checks of the direct costs shown for specific planning elements agreed with these overall comparisons. Although there is room for improvement, the comparisons suggest that the factors are reasonable portrayals of ARF costs, as projected in the *F&FP*.

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*The military personnel costs are limited to the Air Force budget and exclude any estimates of imputed retirement costs.

III. INDIVIDUAL SQUADRON SYSTEM COST ANALYSIS

Before proceeding to the total force analyses that serve to demonstrate the use of the FORCE cost model, we would like to offer some preparatory background information regarding active force and ARF cost relationships. For this purpose we present, below, some system cost comparisons of individual active and ARF squadrons* to indicate (1) the magnitude of the cost differential between similarly equipped and constituted active force and ARF units; (2) the characteristics that tend to make ARF flying units less costly than analogous active force units; and (3) the anticipated effect on the basic ARF cost estimates of varying UE aircraft strength, beddown, and activity levels, i.e., annual flying hours and man-days. Also, since the flying hours of the active forces are programmed to decline over the next few years, as simulators are introduced, we can compare the effects of flying-hour changes on ARF operating costs with the somewhat less-pronounced cost effects of flying-hour changes in the active forces.

As large computer cost models, such as FORCE, are not convenient or economical for estimating the system costs of individual flying units, the estimates in this section were computed manually. However, we used the cost model's conceptual framework and essentially the same factors,† so the resultant estimates approximate what a series of computer runs with the corresponding cost model inputs would have yielded.

The costs shown in this section contrast the *incremental costs* of operating an additional unit of the specified type in the active and reserve forces. The term "incremental costs" is stressed because we are concerned with the differential cost impact of alternative force changes on the Air Force budget. Thus no arbitrary prorata allocations

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*The squadron system cost includes all direct and indirect costs generated by the aircraft squadron. Besides the pay and operating cost of the aircraft squadron it includes the incremental costs of command/staff overhead, aircraft and munitions maintenance, weapon system security, variable BOS, and other support.

†See Sec. II, Tables 2, 3, 5, and 6. The manning figures in the squadron system cost analysis are more detailed than the cost model factors but the totals are the same.

are made of the cost of common, or shared, activities that would continue essentially unchanged by marginal force changes. We do, however, include the indirect costs incurred by non-organic support activities, such as depot maintenance, that are generated by the specified flying units. Also, as was noted in the previous section, we include the out-of-pocket costs of services provided to ARF units and personnel by the active establishment without reimbursement, e.g., the staff pay and other training costs of ATC schools. The costs are expressed in 1976 dollars. To illustrate the costing approach and, later, to serve as the example of how variations in the major operating assumptions alter the basic operating cost estimates, we use an aircraft that is common to both the active forces and the ARF--the C-130E.*

MANPOWER AND ORGANIZATION

The compositions of active and ARF 16 UE C-130E flying units, including their tactical support, variable BOS, and medical support, are shown in Table 9. The equivalent of the latter variable BOS and medical support activities, for deployable ARF flying units such as a C-130 squadron, is the mobility support flight. *It contains all of the essential elements of the BOS function that are needed to augment the host BOS group at the base to which the ARF unit is programmed to deploy in wartime.*

Fixed BOS (the so-called base opening package) is omitted from the active force manpower totals because it is assumed that the active unit would be located on an existing base. The ARF unit also is assumed to be located on an existing base--a commercial airport in this example. Since the ARF reservist support activities, other than the mobility support flight, appear to be justified primarily on Air-Force-wide post-mobilization requirements rather than on the needs of the flying unit with which they are collocated,† they were omitted from the ARF C-130

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*Specifically, an ANG C-130E unit located on a commercial airport is used to represent the ARF. A comparable USAFR C-130 unit, similarly based, would exhibit certain minor differences but the total costs would not be noticeably different from those of the ANG example.

†See Ref. 2, Sec. VI, for a discussion of the ARF support personnel issue.

Table 9

COMPOSITION AND MANPOWER REQUIREMENTS OF ACTIVE FORCE AND ARF 16 UE C-130E SQUADRONS AND THEIR INCREMENTAL SUPPORT

Manpower Function	Officers	Airmen	Total Military	Civilians/ Air Technicians	Grand Total
Active Force					
Command staff overhead[a]	14	29	43	4	47
Line aircrews	96	64	160	0	160
Aircraft maintenance	7	312	319	0	319
Weapon system security	0	10	10	0	10
Subtotal	117	415	532	4	536
Variable BOS/medical	3	60	63	41	104
Grand total	120	475	595	45	640
ARF					
Command staff overhead[a]	25	40	65	54	
Line aircrews	96	64	160	0	
Aircraft maintenance	7	349	356	123	
Weapon system security	1	30	31	1	
Subtotal	129	483	612	178	
Mobility support flight	2	62	64	--	
Variable BOS/medical	--	--	--	63	
Grand total	131	545	676	241	

[a]Includes personnel on flying status.

unit manning. Also, following active force costing practice, the aerial port and aeromedical evacuation units were omitted from the comparison.

Inspection of the respective active and ARF manning authorizations for what would seem to be comparable wartime missions reveals some minor variations. The ARF unit has more personnel authorized for the aircraft maintenance and weapon system security activities than the active unit seems to require, although both sets presumably are based on the same wartime flying-hour and security assumptions. The reason for the extra maintenance personnel seems to lie in the Air Force's decision in 1974 not to apply its new 242 hours per month wartime maintenance criterion to the reserve forces, since it would result in the loss of trained

maintenance reservists.* The reason for the disparity in aircraft guard strength is not clear but the numbers involved are not great.

The command/staff overhead figures represent the tactical squadron staff, plus a prorata share of group and wing headquarters. Headquarters personnel in BOS-type activities are included in the BOS figure for the active unit. This could not be done in our ARF manpower tabulation, which may account for at least a part of the somewhat lower active command overhead figure and higher BOS. In any event, the crew manpower is the same for the active and ARF units and the overall manpower totals are only slightly different: 640 and 676, respectively

The major manpower difference is in the ARF unit's cadre of Air Technicians which provides for the aircraft maintenance and day-to-day operation of the ARF unit in peacetime.† The number of Air Technicians is not additive to total unit manpower, however, because they also are required to be reservist members of their units. Since in their Air Technician role they are paid out of O&M funds and they are administered under civil service regulations, it is convenient to tabulate them as a separate manpower category; however, in an operational sense, they are difficult to distinguish from active duty military personnel--and they form a significant fraction of the unit's total manpower. The number of maintenance Air Technicians is predicated on the unit's peacetime flying program, which has cost implications for alternative operational concepts that affect the ARF peacetime flying rate.

PEACETIME ANNUAL FLYING HOURS

Not only do reservists (excluding those who also are Air Technicians) participate in unit activities on a part-time basis, but the ARF aircrews fly only about one-half as much as their active counterparts. Because of the relatively larger proportion of rated overhead personnel in the ARF units, however, the overall peacetime flying-hour total for an ARF unit, in general, is only about one-third lower than that of a similarly

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*Reference 18, p. 428. This disparity in the guidance has since been eliminated so our ARF squadron costs may be overstated slightly.

†The USAFR uses non-Technician civil service personnel for many of its support functions. See Ref. 2, Sec. VI.

equipped active unit--about 6600 for the 16 UE C-130 ARF unit compared with 10,400* for the active force unit. (Both active and reserve airlift crews fly a considerable number of support missions in addition to their normal training requirements and this additional flying raises their average rate to about one-third more than that of tactical fighter aircraft crews.)

SYSTEM COST COMPARISONS

Table 10 contrasts the total annual system costs of the active and ARF C-130E units described above. Looking first at the bottom line of the table, the ARF unit's total system costs are seen to be approximately 30 percent less than those of the active force unit†--given the same UE aircraft strength, the normal participation and flying rates of the ARF unit, and basing of the ARF unit at a commercial airport. The effect on costs of varying these assumptions will be discussed below.

It will be noted that the reservist pay and training amount to only one-fourth of the amount spent on the comparable active duty personnel; however, when all of the personnel-related costs--including Air Technician pay--are taken into account, the ARF figure rises to nearly 70 percent of the active unit's personnel cost total.

The costs that are related to flying hours scale directly with the flying-hour differential that was noted above, so that these costs are about one-third lower for the ARF unit. Overall, the ARF C-130E unit's lower personnel-related costs account for slightly more than half of the $5.5 million annual cost difference between the corresponding active and ARF units, and the flying-hour cost disparity accounts for the rest.

We made similar cost comparisons for tactical reconnaissance, attack, and fighter aircraft units that are common to the active and reserve forces.‡ The results, summarized in Table 11, show roughly the

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*Military Airlift Command FY 1976 average programmed flying hours for C-130E/H aircraft squadrons.

†These cost estimates are limited to the Air Force budget and exclude any allowance for military retirement.

‡Reliable data were not available at the time of the study to permit the inclusion of the KC-135. The F-4E is not yet in the ARF inventory but there were several RF-4C units and an F-4C unit in the ANG to use as analogs for our estimate.

Table 10

COMPARISON OF THE ANNUAL SYSTEM COSTS OF ACTIVE AND ARF 16 UE C-130E SQUADRONS[a]

($ millions)

Cost Element	Active	ARF
Aircraft-related		
Cost/UE	1.6	1.6
Modifications	(0.1)	(0.1)
Support equipment	(0.1)	(0.1)
Depot maintenance (part)	(1.4)	(1.4)
Cost/flying hour	6.4	4.1
Depot maintenance (part)	(1.3)	(0.9)
Replenishment spares	(0.7)	(0.4)
POL	(3.6)	(2.3)
System/general support material	(0.8)	(0.5)
Personnel-related	9.8	6.6
Air Technician/civilian pay	(0.6)	(3.9)
Military pay	(6.9)	(1.7)
Replacement training	(1.3)	(0.5)
Miscellaneous	(1.0)	(0.5)
Grand total	17.8	12.3

[a]Manpower and flying hours are as shown in Table 1.

Table 11

ACTIVE/ARF ANNUAL SYSTEM COST COMPARISONS FOR SELECTED AIRCRAFT SQUADRONS

($ millions)

Aircraft Type	UE	Crew Ratio	Active: Annual Flying Hours	Active: Cost	ARF: Annual Flying Hours	ARF: Cost	Cost Difference	ARF/Active Cost Ratio
C-130E	16	2.00	10,400	$17.8	6,609	$12.3	$5.5	.69
RF-4C	18	1.25	6,120	15.6	4,285	11.2	4.4	.72
A-7D	24	1.25	7,260	14.9	5,165	10.1	4.8	.68
F-4E	24	1.25	7,560	21.1	5,165	13.8	7.3	.65

same comparative results as the C-130 example--again assuming the same UE strength for active and ARF units, normal reserve activity levels,* and basing at commercial airports.

Since the lower costs exhibited by the ARF stem primarily from their flying fewer hours than active force units, and from the part-time nature of reservist participation, the ARF units may tend to be somewhat less capable or less combat-ready than analogous units in the active force--at least for highly sophisticated, multimission aircraft. The cost of increasing ARF flying rates and man-days is addressed at the end of this section, but it is questionable whether reservists would be willing to devote significantly more of their free time to their part-time military careers than they do at present. Thus the active/ARF force mix tradeoff analyses may take the form of identifying those transfers of aircraft and missions that offer the greatest savings commensurate with their expected loss in military capability. (See Ref. 2, Sec. V, for a more complete discussion of these points.)

ECONOMIES OF SCALE

Because of minimum requirements of specialized skills, base facilities, and maintenance equipment at each separate operating location, there are cost economies associated with having fewer but larger aircraft squadrons. Yet the ARF force structure is dominated by squadrons that are under-equipped by active force standards.† For example, ARF fighter squadrons typically have 18 aircraft, whereas the active squadrons typically have 24. In the previous C-130 discussion, a 16 UE ARF squadron was used as our example; yet only three of the present 30 ARF C-130 squadrons have 16 UE, the balance being, in essence, half-squadrons of 8 UE each. The same is true of the KC-135s now entering the reserve inventory. Most 8 UE squadrons are separately based, each having its

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*Missions that require greater than normal participation or flying-hour levels, e.g., the ANG's air defense alert, would tend to save less than these examples show.

†Here and elsewhere in the report our characterization of certain ARF squadrons as "under-equipped" refers to their lower UE aircraft strength compared with typical active force squadrons having the same aircraft.

own contingent of support organizations and self-sufficient maintenance squadrons.

Table 12 compares the manning and cost of a pair of 8 UE C-130 squadrons with those of a single squadron with 16 UE. Both have essentially the same wartime operational capability--except for any benefits

Table 12

COMPARISON OF TWO 8 UE C-130E ARF SQUADRONS
WITH ONE 16 UE SQUADRON

Item	One 8 UE Squadron	Two 8 UE Squadrons	One 16 UE Squadron	Difference[a]
Manpower				
Officers	80	160	131	29
Airmen	306	612	545	67
Total military	386	772	676	96
Maintenance Air Technicians	75	150	123	27
Other Air Technicians	83	166	118	48
Total Air Technicians	158	316	241	75
Annual flying hours	4,017	8,034	6,609	1,425
Annual system costs ($ millions)				
Personnel-related	4.1	8.2	6.6	1.6
Military	(1.6)		(2.7)	
Air Technicians	(2.5)		(3.9)	
Aircraft-related	3.3	6.6	5.7	0.9
UE costs	(0.8)		(1.6)	
Flying hour costs	(2.5)		(4.1)	
Total	7.4	14.8	12.3	2.5

[a]16 UE squadron compared with two 8 UE squadrons.

that *may* result from the additional rated personnel in the duplicated wing/group overhead structure or from the ability to deploy smaller self-sufficient units. Because of the additional reservist and Air Technician personnel in administration and support functions that are necessitated by the two separate bases, and also because of the additional flying hours of the rated overhead personnel, the two half-size

C-130 squadrons exceed the annual cost of the single 16 UE squadron by an estimated \$2.5 million.*

Table 13 compares the cost of an active C-130E squadron with a pair of 8 UE ARF squadrons and with one 16 UE squadron. The annual savings are about 15 percent and 30 percent, respectively. A more

Table 13

COMPARISON OF ALTERNATIVE BEDDOWNS FOR 16 C-130E AIRCRAFT

Item	Active One 16 UE Squadron	ARF Two 8 UE Squadrons	ARF One 16 UE Squadron	Two 8 UE Squadrons Augmented to 16 UE
Manpower				
Military	595	772	676	580
Air Technician/civilian	45	316	241	166
Annual flying hours	10,400	8,034	6,609	5,184
Annual system costs (\$ millions)	17.8	14.8	12.3	9.8[a]

[a]16 UE squadron (\$12.3) less 8 UE squadron (\$7.4) = incremental cost (\$4.9 million) of each of the two augmented squadrons.

cost-effective way to bed down 16 additional C-130s, however, without loss of total force structure,† is to augment two existing 8 UE ARF squadrons, raising each to 16 UE strength, the active force standard. This eliminates the base opening costs and the duplication of administrative overhead--and the additional flying-hour costs they require. At \$9.8 million, this constitutes a saving of nearly one-half of the active squadron cost.

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*See Ref. 19 for a similar analysis and conclusion.

†The potential saving from a transfer of aircraft from the active forces accompanied by a concurrent phaseout of obsolescent ARF aircraft is included in the discussion of total force costing in the next section.

Increasing the 18 UE fighter squadrons to 24 UE strength does not yield savings that are quite as dramatic as in the C-130 example. Nevertheless, the total potential savings from augmentation or consolidation across the whole force structure cannot be considered trivial by any standard.

Except for unusually isolated locations where local communities are hard-pressed to support even the present unit of reduced size, the concept of augmenting the existing under-equipped squadrons should always be considered ahead of the establishment of new squadrons, with the implied duplication of overhead and attendant expenditures on base facilities, runway extensions, erection of barriers, etc.*

BEDDOWN

Support manning economies associated with the beddown of ARF squadrons on active Air Force bases rather than on commercial airports are discussed in Sec. VI of the companion report (R-1977/1-AF). Table 14 translates the savings into dollars, using the basic 16 UE ARF C-130 squadron figures from Table 13 together with estimates for a similar USAFR† unit located on *an active Air Force base.*

The manning of the tactical elements of the flying unit is not significantly influenced by the type of basing. However, the USAFR civilian BOS for the Air Force base beddown case totals a mere 17 people,‡ since the fixed BOS already is funded and the USAFR relies on the host to provide a portion of its other support needs as well.** The savings per C-130 squadron that result from the Air Force base beddown amount to about $0.6 million a year (5 percent). If we consider the effect of an Air Force base beddown on the full reservist organization--including the entire array of civil engineers, combat support,

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*See Ref. 2, Sec. VI, for a discussion of this issue.

†ANG base support does not differ noticeably by type of beddown.

‡The total USAFR civilian BOS for groups located on active Air Force bases averages 32, including that needed for the collocated support elements.

**The variable BOS provided by the host is included in our cost estimate.

Table 14

INFLUENCE OF BEDDOWN ON SYSTEM COSTS OF
USAFR 16 UE C-130E SQUADRONS

Item	Commercial Airport	Active Air Force Base
Manpower		
Reservists	676	676
Air Technicians/civilians		
BOS	63	17
Other	178	178
Active military BOS	--	7
Annual costs ($ millions)		
Personnel-related	6.6	6.0
Aircraft-related	5.7	5.7
Total	12.3	11.7

and other BOS functions--the annual savings would approximate $1 million per group.

In addition to the savings in support manpower, there may also be some surplus facilities on the active Air Force bases that could be utilized by the reserve units. There are other advantages as well, such as the availability of certain amenities that are normally furnished on Air Force bases for the benefit of assigned personnel, the presence of all kinds of specialized skills and equipment in the active force units that would be located nearby, and the advantage of readily accessible LOGAIR transportation. In view of these considerations, the active Air Force base appears to be the preferred beddown for ARF squadrons, limited only by the obvious prerequisite of a nearby* population center large enough to support a reserve operation.

COST EFFECT OF CHANGES IN ACTIVITY LEVEL

As is discussed in Sec. V of R-1977/1-AF, for certain aircraft the designed operational capability (DOC) of ARF units is less than

*Many members of the Cheyenne ANG unit live in the Denver area, 100 miles from the base.

that of their active counterparts because of lower ARF training rates. It does not necessarily follow that all crews--active duty and ARF--should have to meet the total DOC requirements. Nonetheless, it may be useful for planners to know what the cost of increasing ARF flying hours might be, in order to provide some financial input to the decision of what proportion of a total mission area should be delegated to the ARF--and, of that, what proportion of the ARF should be proficient in the total DOC.

It also should be recognized that a portion of the C-130 active duty flying is in support of Army training. Therefore, although a number of additional C-130s could be transferred to the reserve with the remaining C-130s in MAC accepting a larger share of Army support flying, at some point it would become necessary for the reserves to take responsibility for some of the Army support missions.

Using C-130 and F-4 squadrons for illustrative purposes, Table 15 indicates the cost implications of 10, 20, and 30 percent increases in annual crew flying hours in the ARF, if this is feasible. The aircraft-related cost elements that are sensitive to the number of flying hours--POL, replenishment spares, etc.--would tend to scale with the increased level of activity. Besides these flying-hour costs, there would be an augmentation to the number of maintenance Air Technicians, as they are predicated on the peacetime flying program.* We have assumed further that additional aircrew man-days will be required at the rate of one man-day for each two additional flying hours. The *reservist* maintenance manning is based on wartime requirements, however, and would not be affected by changes in peacetime flying rates.

The estimates given in Table 15 reveal the sensitivity of ARF costs to peacetime flying hours based on the above assumptions and the available cost factors. They indicate that on the basis of cost alone, the flying-hour requirements for mission training are an important consideration in selecting appropriate missions for the ARF.

The flying hours shown for active squadrons in the earlier tables used present flying-hour levels as the basis for estimating

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*This manning criterion assumes a linear relationship--so many direct maintenance man-hours per flying hour.

Table 15

SENSITIVITY OF ARF C-130E AND F-4E SQUADRON COSTS TO INCREASES IN FLYING HOURS FOR PRIMARY AIRCREWS

Item	C-130E (16 UE)				F-4E (24 UE)			
	Annual Flying Hours	Additional Flying Hours			Annual Flying Hours	Additional Flying Hours		
		+10%	+20%	+30%		+10%	+20%	+30%
Annual flying hours								
Primary crew	5,184	+518	+1,037	+1,555	3,645	+365	+729	+1,094
Overhead crew	1,425				1,520			
Total	6,609				5,165			
Additional flying hours/crew		16	32	48		12	24	36
Additional man-days/crew		8	16	24		6	12	18
Additional man-days/total crews		256	512	768		180	360	540
Maintenance Air Technicians		+11	+22	+33		+10	+20	+30
Annual system costs ($ thousands)								
Basic cost	12,300	12,300	12,300	12,300	13,800	13,800	13,800	13,800
Additional crew man-days[a]	--	56	112	168	--	19	39	58
Additional maintenance Air Technicians	--	165	330	495	--	150	300	450
Additional flying hours-related	--	318	637	955	--	385	768	1,153
Total	12,300	12,839	13,379	13,918	13,800	14,354	14,907	15,461
Cost increment (%)	--	4	9	13	--	4	8	12

[a]Cost-crew man-day: C-130E--3 officers at $54 plus 2 airmen at $28 = $218; F-4E--2 officers at $54 = $108.

flying-hour-related costs. In the face of ever-increasing POL costs, most active squadrons have been programmed for significantly fewer flying hours by 1981. This reduction is based primarily on the assumption that flight simulators can be substituted for a portion of the actual flying time.

As noted above, in the discussion of ARF flying-hour changes, the number of military personnel assigned to the aircraft maintenance function is derived on the basis of wartime needs and apparently would be unaffected by the proposed reductions in peacetime flying. As a result, *only the costs related to flying hours* would be reduced as a result of the proposed cuts in the active force flying program. Table 16 shows the estimated impact on active squadron costs of reduced annual flying

Table 16

SENSITIVITY OF ACTIVE SQUADRON ANNUAL SYSTEM COSTS[a] TO REDUCED FLYING HOURS

($ millions)

Aircraft	Annual Flying-Hours	Flying-Hour Costs	Other Costs	Total Costs
1977				
C-130E	10,400	6.4	11.4	17.8
F-4E	7,560	8.0	13.1	21.1
1981				
C-130E	7,435	4.6	11.4	16.0
F-4E	5,040	5.3	13.1	18.4
C-130E	Flying-hour cost savings = 1.8			
F-4E	Flying-hour cost savings = 2.7			

[a]Excludes the cost of flight simulators that are intended to substitute for aircraft flying hours.

hours in peacetime.* As the other operating costs would be unaffected by the flying-hour change, the overall percentage cost reduction is considerably less than the percentage drop in flying hours. To arrive at the *net* overall cost savings (if any), we would have to add in the offsetting costs of procuring the simulators plus the costs of operating and maintaining this complex equipment. Studies underway to measure the costs of substituting simulators for airborne flying training have not progressed far enough to provide any conclusive estimation of the net result of added costs and realizable savings. But we judge at present that the net savings could be far less than those indicated in the table.†

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*The flying-hour figures were obtained from Ref. 13. No reduction was indicated between FY 1977 and FY 1981 for the RF-4C and A-7D.

†Moreover, even some flying-hour-related costs, such as replenishment spares, may not be reduced proportionately to the flying hours. Cost-per-flying-hour factors are, at best, only gross approximations of actual demands for resources.

IV. TOTAL FORCE COST ANALYSIS

The examples presented in the previous section treated individual tactical systems and their associated support more or less in isolation. This had the merit of giving a relatively straightforward presentation of the costing approach and insights regarding the reserve operation. The squadron comparisons have some shortcomings, however. Although they attempt to account for incremental costs incurred in the general support areas, they tend to ignore phenomena that are driven by total force considerations. These would include inheritance of surplus resources, base openings and closings, and expansion or contraction in the logistics support and training infrastructure. Decisions involving one or two force elements seldom affect these latter two areas; they are a result of the combined effects of numerous force structure decisions. The reserve force structure also has some political constraints that bear on overall costs.

As was discussed in Sec. II, we incorporated ARF cost estimating routines into the FORCE cost model and we expanded its data base to include all of the ARF aircraft and support elements. The various data base inputs reflected the then-programmed force structure, manpower, and activity levels of the Air Force, and the cost model--acting on these inputs--produced cost projections that closely approximated the corresponding figures in the *F&FP*. Having established this base-line case, simple changes in the force structure inputs could produce printouts showing the cost implications of specified force alternatives, including transfers from the active forces to the ARF, representing either force augmentation or replacement of obsolete equipment. In the latter case, the net cost would take account of the value of the resources released by the system being phased out. Changes in the personnel and activity level inputs would test the cost impact of alternative flying-hour rates, crew ratios, and squadron UE. Fixed BOS (base opening package) personnel strengths could be manipulated to simulate the opening or closing of bases, training schools, and depots.

To demonstrate the operation of the cost model while adding a cost dimension to some of the options discussed in the companion report (R-1977/1-AF), a set of examples was selected that relates to active/ARF tradeoffs and to measures intended to improve ARF operations. The inputs that are required by the cost model to run these cases are explained at length in Ref. 4. In the paragraphs below we summarize the results of the cost model runs.

ARF COMBAT SUPPORT REQUIREMENTS AND COST

Establishing separate planning elements for each type of BOS activity--medical, combat support, civil engineers, etc.--rather than including them all as parts of the aircraft squadron planning elements facilitates the analysis of the Air-Force-wide wartime requirements for reserve personnel in each of these functions. The cost model can estimate the cost implications of specified manpower cuts or of reduced training man-days in the various support functions by simple adjustments in the appropriate data sets. For our example, we eliminated ARF combat support personnel in all units having mobility support flights, which augment existing support units on active bases in wartime.* These cuts resulted in annual savings estimated at more than $60 million compared with the base-line case.† As is shown in Table 17, this amount includes the ripple effects of these manpower cuts on peacetime BOS requirements and on training costs, including an approximation of the incremental costs incurred by the Air Training Command schools.

The cost model also can estimate the total force net savings that could result from reducing the peacetime strength of active force support functions, where this is feasible, and augmenting the corresponding reserve support elements by a like number of wartime fillers.

FLYING PROGRAM REVISION

The concept of differential treatment of "transition" units--those equipped with obsolescent aircraft--is introduced in Sec. VI of

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*The combat support may be superfluous (see Ref. 2, Sec. VI).

†The ARF modernization programmed in our source, Ref. 7, has not yet been fully implemented. Therefore, the estimated savings shown in Table 17 are overstated somewhat.

Table 17

POTENTIAL ANNUAL SAVINGS FROM ELIMINATING ARF COMBAT SUPPORT OTHER THAN FOR AIR DEFENSE UNITS

($ millions)

Activity	Savings
USAFR combat support	8
ANG combat support	45
Peacetime BOS[a]	10
Training (students)	6
Air Training Command	2
Total	71

[a]Provided by ARF civilians/Air Technicians.

R-1977/1-AF. The present policy is to man and operate units having minimal wartime utility at the same combat-ready state as those equipped with modern aircraft. The apparent motives for this policy are to maintain aircrew proficiency and to preserve the mobilization base and unit integrity of these squadrons. This is intended to expedite an orderly transition to newer aircraft when they become available. On the assumption that this could be accomplished with a somewhat lower level of day-to-day readiness, the cost model was employed to measure the probable cost effects of such a change in policy, as follows:

The inputs of annual flying hours for line and overhead crews in squadrons equipped with obsolescent aircraft* were reduced to 100 hours, the AFR 60-1[20] minimum required to maintain an administrative or "mission-capable" level of proficiency. In addition, the F-100 and F-105 combat crew training squadrons were put on standby until their transition to F-4s and A-7s. The effect of these combined cuts, as indicated by the cost model run, would be significant.

The specified flying-hour reduction led to immediate reductions in the costs shown for activity-related resources such as POL and depot maintenance. These accounted for about one-half of the calculated savings.

*For our illustration, we used RF-101, A-37, 0-2, F-100, F-105, C-123, KC-97, and C-7 aircraft to represent obsolescent equipment.

The impact on personnel costs was felt primarily in the aircraft maintenance Technician area because their strength is determined on the basis of the peacetime flying-hour levels. The first-cut estimate of the five-year savings that could stem from these measures was $120 million, more than half of it in 1977-1978, before the F-4s and A-7Ds begin to phase into the ARF in appreciable numbers. However, in the case of squadrons due for early transition into new aircraft, the potential civilian cost savings were overstated, since it is not likely that maintenance Technicians would be discharged and others recruited a year or so later. Therefore, a second run was designed in which no reductions in Technicians were made in squadrons that were programmed to convert before 1980. As is shown in Table 18, the approximate five-year savings under this constraint would still be an impressive $107 million.

Table 18

COST SAVINGS FROM REDUCED ANNUAL FLYING HOURS FOR TRANSITION AIRCRAFT[a]

($ millions)

Cost Element	1977	1978	1979	1980	1981	5-Year Total
POL	17	11	8	4	3	43
Depot maintenance	4	3	2	1	1	11
Civilians	9	8	8	6	4	35
Other[b]	6	5	4	3	--	18
Total	36	27	22	14	8	107

[a]Minimum of 100 flying hours annually per crew, as specified in Ref. 20.

[b]Replenishment spares and general/system support material.

It should be noted that the overall savings shown in the table would increase after 1980 if other aging aircraft were added periodically to the "transition" list and flown less.

The impact of other policy decisions that would bear on activity levels may be estimated by the cost model in similar fashion.

TRANSFER OF ADDITIONAL SQUADRONS TO THE ARF

The following examples demonstrate the use of the cost model in an evaluation of the transfer of equipment from the active forces to the ARF.

The transfer was assumed to occur in 1978. For simplicity, we chose a single aircraft type: six squadrons of C-130s (96 aircraft). It might have been more realistic to consider several small force transfers of a variety of aircraft types; however, use of a single aircraft simplified the input requirements, and the implications, particularly of the beddown options, were believed to be easier to comprehend with a single aircraft type.

Four variants were developed to highlight the issues involved in determining the preferred ARF beddown for the transferred aircraft. The first three cases are basically similar to the C-130 examples used earlier, wherein we described the effect of economies of scale on ARF aircraft system costs. The total force structure remains unchanged--the transfer merely represents a small shift in the active/ARF mix. The basic differences that define these variants follow:

A. Twelve new ARF 8 UE squadrons were formed, six each for the USAFR and ANG. This is the most prevalent UE strength for ARF C-130 squadrons, although active squadrons have 16. The squadrons were assumed to be located at commercial airports that needed a minimum of new construction.

B. A variant of (A) was tested in which the USAFR and ANG each established three new 16 UE squadrons, to benefit from the inherent economies of the larger UE strength.

The third variant profits from the fact that the ARF already has a number of C-130 squadrons which (as is typically the case for ARF units) are under-equipped.

C. Twelve of the existing C-130A, C-130B, and C-130E squadrons that are presently equipped with 8 UE aircraft were doubled in size, thereby averting the need for additional bases,

fixed BOS, and organizational overhead structures.* To avoid mixed squadrons, the C-130s were redistributed as shown in Table 19 to form 16 UE units of the same aircraft series.

Table 19

FY 1978 ARF BEDDOWN FOR C-130A/B/E AIRCRAFT: CURRENT PROGRAM AND WITH 96 C-130E AUGMENTATION

Beddown Assumption	C-130A/B			C-130E[a]			
	8 UE	16 UE	Total	8 UE	16 UE	Total	Total[a]
Current program							
Squadrons	20	1	21	5	2	7	28
Augmentation program							
Squadrons	12	5	17	1	10	11	28
Change							
Squadrons	-8	+4	-4	-4	+8	+4	0
UE aircraft	-64	+64	0	-32	+128	+96	+96

[a]Excludes ANG C-130E squadron based in Alaska.

The fourth variant addressed the chronic problem of having large numbers of obsolescent "transition" aircraft squadrons in the ARF posture:

D. The acquisition of the C-130s was joined by the concurrent phaseout of 12 ARF transition squadrons: three C-7 squadrons, four C-123 squadrons, and five C-130A squadrons. This variant required very little in the way of *additional* resources as the organizations and most of the required manpower and base facilities already existed.† However, in this variant there was a

*This option is not limited to cargo aircraft. Additional ARF squadrons could be consolidated to permit the acceptance of additional aircraft in the ARF force structure by increasing the typically low UE strength to the levels common in the active forces, e.g., 18 instead of 15 for the F-106, and 24 instead of the 18 UE assigned to most ARF fighter squadrons.

†And presumably would continue to exist despite their marginal military value.

> reduction in our total force posture, and a loss of whatever military capability is attributable to these obsolescent aircraft.*

An additional run was made to compute the savings associated with the closure of an active Air Force base.

The year-by-year savings that could result from transferring six 16 UE squadrons of C-130s from the active inventory, and the partially offsetting operating costs of the four alternative C-130 ARF beddowns are depicted in Fig. 1. The active force savings (above the line) appear as positive values in the diagram.

The transfer is assumed to occur in mid-FY 1978; therefore, the active force savings peak in FY 1979, the first full year without the aircraft. The rate of savings then declines until FY 1981, because of the programmed reduction in flying hours for active squadrons.† Training leadtime accounts for the minor savings indicated in FY 1977, the year prior to the transfer. The dashed line shows the additional estimated savings that could result from closing a MAC base in conjunction with the transfer.

The relative operating costs of the four ARF alternative C-130 beddowns are readily compared in the lower (negative value) region of Fig. 1. Each of these offsetting cost curves is combined with the active force savings curve (without the base closure) in Fig. 2 to show the resultant net savings from the C-130 transfer under different ARF basing assumptions. These net savings reflect the reduced flying program of ARF squadrons, lower annual pay of reservists compared with full-time active personnel, and the considerably lower BOS and training requirements of reserve personnel.

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*In the case of cargo aircraft this might be an important consideration. However, for 20-year-old fighter aircraft, the net loss in capability might not be measurable.

†The savings are understated to some extent because the cost of the flight simulators that make these flying cuts possible was excluded. (The inclusion of simulator costs in the active costs would increase the spread between the active and ARF totals that appear in Fig. 1.)

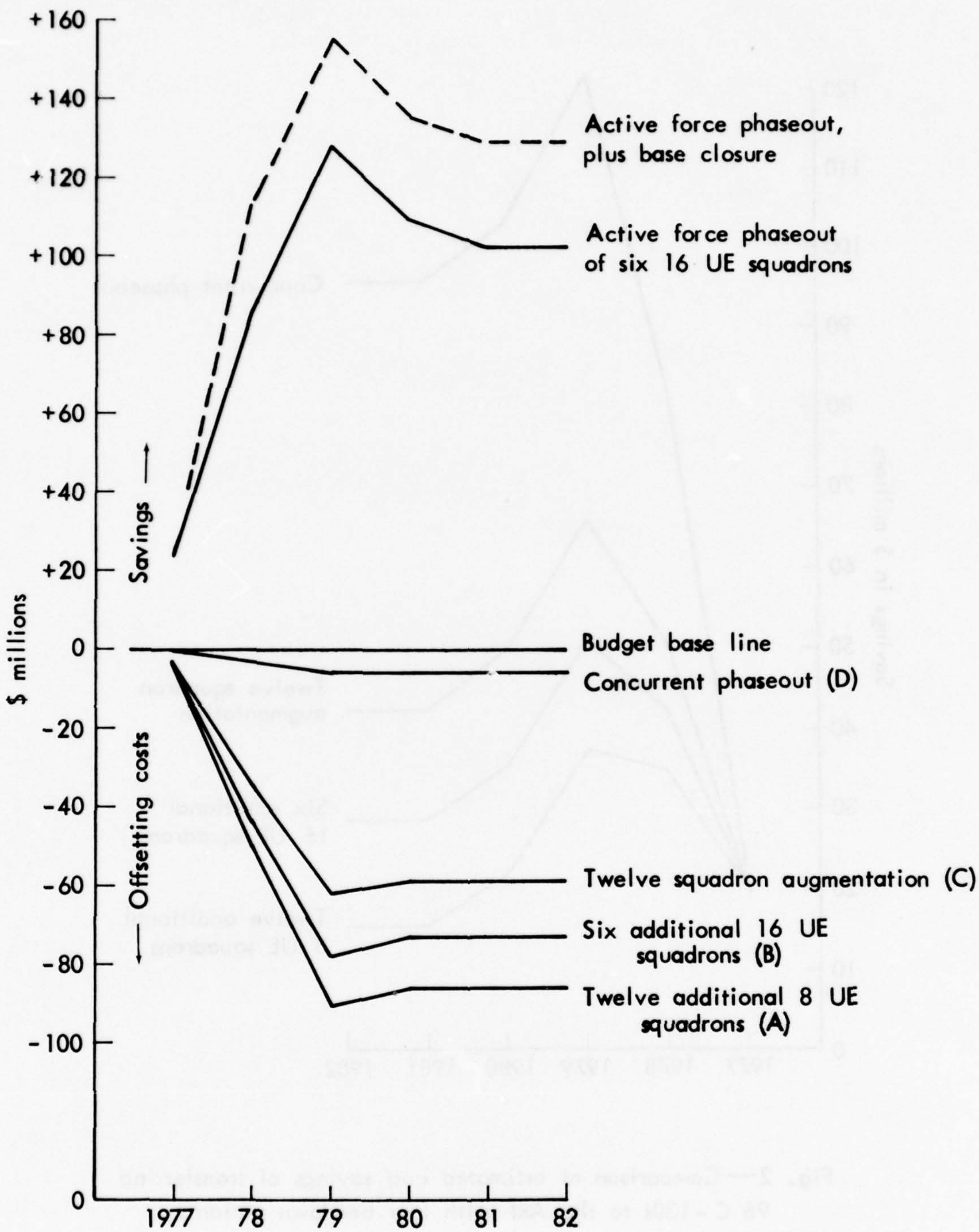

Fig. 1—Active force savings (+) and offsetting ARF added costs (-) of transferring 96 C-130s from the active inventory to the ARF with four beddown variants

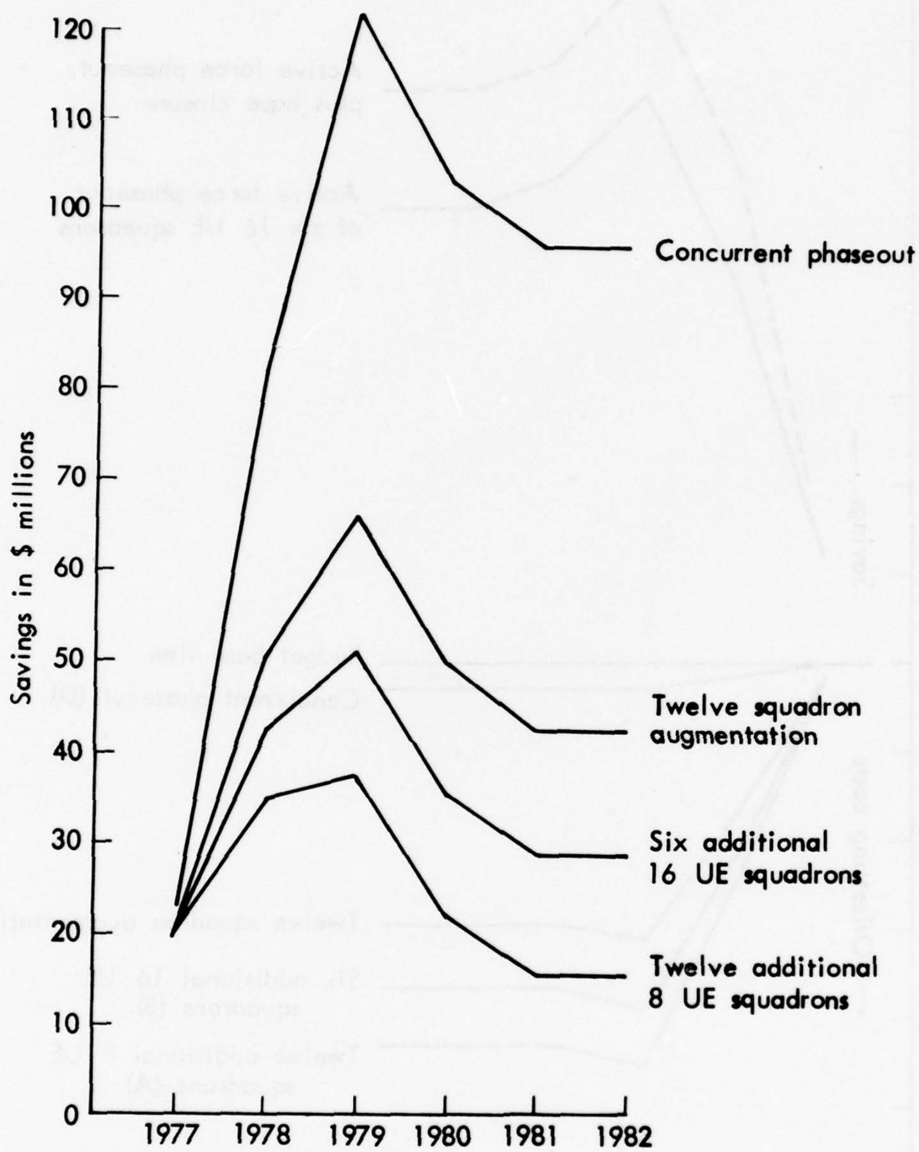

Fig. 2—Comparison of estimated cost savings of transferring 96 C-130s to the ARF with four beddown variants

If the C-130s are assigned to 12 additional 8 UE ARF squadrons (Case A), the typical C-130 deployment, the savings in operating costs during the five-year period of FYs 1977 to 1981 are estimated at about $132 million. Twelve additional BOS base opening packages and flying unit overheads are required, together with the additional flying-hour costs generated by the rated members of the overhead organizations. The savings level off at $16 million per year after 1981.

If, instead of 8 UE, the squadrons are equipped with 16 UE aircraft each (Case B) the number of additional fixed overhead increments (including BOS base opening packages) can be reduced to 6 and the five-year savings could increase to an estimated $178 million with a level-off annual saving of $29 million. The greatest amount of savings without any loss of force structure occurs with the augmentation of 12 existing 8 UE C-130 ARF squadrons, raising their UE to 16 (Case C). In this beddown option there is no increase in fixed overhead and the estimated five-year savings could reach the level of $226 million, with level-off savings estimated at $43 million a year. Finally, if the loss of military capability represented by 12 squadrons of aging C-7s, C-123s, and C-130As can be tolerated, they can be replaced with the newer C-130Es and the net five-year budgetary savings will amount to about $426 million. Level-off annual savings for this option are estimated at $96 million. Closing a large active Air Force base in conjunction with any of these transfer options could add another $25 million or so to the net savings per year.

Case B produces the greatest savings attributable solely to the specified transfer of aircraft from the active to the reserve forces. Cases C and D derive a large part of their savings by cashing in, respectively, on the potential economies of scale that unit consolidations could generate in the present under-equipped ARF force posture, and the savings from eliminating squadrons of limited wartime utility. These latter savings could, of course, be realized without the transfer of aircraft from the active forces were it not for the present adherence to an unchanging number of ARF squadrons. However, as long as this constant force policy prevails, substantial budgetary savings can be achieved simply by more fully utilizing the ARF resources that are maintained.

In addition to the above annual costs estimated by the cost model, these transfers would require a year or two of active force personnel support to train the crews and aircraft maintenance personnel, and some base facilities might have to be constructed at the new locations.

These investment costs would be minimized by the Case C and Case D beddowns which in the former case already have an inhouse capability to train the augmentation personnel, and in the latter case would require few if any new facilities.

Up to this point we have focused on the short-run implications of the specified transfer of aircraft from the active forces to the ARF. However, such changes in the programmed force structure have future repercussions as well. The FORCE cost model with its long-range force projections permits these future ramifications to be brought into the analysis.

The ARF is equipped primarily with aircraft from the active forces that become surplus as new first-line equipment is procured and phased into the active inventory.* Therefore, if we specify that "additional" squadrons be transferred to the ARF in FY 1978, it should be recognized that these aircraft already are planned for the ARF at a future time, as they are displaced by newer aircraft in the active inventory. For example, an advanced medium STOL transport (AMST) is presently programmed to replace the active force C-130s in the not too distant future. The active force C-130s that are displaced will be transferred to the ARF where they will, in turn, replace the aging transport aircraft that are presently in the ARF inventory.

Our C-130 transfer cases essentially *advanced* the date of phaseout of six of MAC's C-130 squadrons. Cases A, B, and C reduced the active forces and added new squadrons (or squadron augmentations) to the ARF. However, if no provision is made for the 12 ARF squadrons that were originally scheduled to receive these aircraft in the future, the cost model--acting on the base-line force structure inputs--will phase them out. It will also compute the cost of acquiring and training the active

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*Notable exceptions are the two squadrons of new A-7s authorized specifically for the ANG, and the programmed allocation of some new A-10 and F-16 squadrons to the USAFR and the ANG.

duty personnel needed to man the six new AMST squadrons, which will represent an active force buildup. These two actions--the phaseout of ARF squadrons and the phasein of AMSTs in the active force structure--will essentially restore the present active/ARF mix. Although all of this is done automatically by the cost model in the absence of inputs to the contrary, in real life such a force mix flip-flop would not be so simple to engineer.

Case D avoids the ARF personnel turbulence of the first three cases by simply advancing the date of the transfer of C-130 aircraft from MAC to the ARF squadrons that are now programmed to receive them. This, of course, will result in a temporary loss of total force structure (the ARF's aging C-7s, C-123s, and C-130As) until the arrival of the AMSTs. Like the other cases, however, unless additional forces are transferred from the active inventory to the ARF to offset the eventual phasein of AMSTs to the active inventory, the active/ARF mix will return to its present ratio, and the indicated annual savings will come to a halt.

In view of these future consequences it might be more reasonable to approach the force mix problem in terms of missions (or shares of missions) rather than of particular aircraft models. In any event, the planner should take advantage of the long-range planning horizon of the FORCE cost model to ensure that a proposed force mix change will not harbor any unpleasant surprises for the future.

GRADE RESTRUCTURING IN THE ARF

One of the policy changes discussed in Sec. VI of the companion report (R-1977/1-AF), and one that merits serious consideration, is grade relief for the ARF. It was proposed that the ARF be composed of experienced prior-service personnel to the extent that they are available and, to promote this concept, that all airman positions below E-5 rank be upgraded to E-5. The discussion presented evidence that, in the case of maintenance personnel, productivity might be enhanced at no great increase in total pay and that, indeed, some savings might be realized, as recruit and basic technical training costs could be drastically reduced. The model was employed to provide an assessment of such a policy change.

Table 20 shows the results of a model run in which the following policy changes were incorporated:

- The base pay factor for reservist airmen was increased to reflect a minimum grade equivalent to E-5.
- The recruit training and basic technical training inputs were reduced to a bare minimum--assumed for this illustration to be 5 percent of the acquisitions. It was assumed further that this grade restructuring policy would lead to the lower turnover rate of 10 percent.

The model run structured as above provided an estimate of the net savings associated with a policy that substituted already-trained E-5 prior-service personnel for nonprior-service recruits who receive less pay but who generate costly recruit training. This estimate is an *a fortiori* case in the sense that no credit is taken for increased productivity and consequent lower manning requirements.* Even with this constraint the financial attractiveness of this policy change is clearly indicated by the model results. As Table 20 suggests, there could be cost savings both in reservist training costs† and in the Air Training Command costs that are attributable to reserve training requirements. These training savings would overwhelm the increased pay costs. The total net value of these savings is estimated at about $25 million a year. If specifics could be generated regarding the probable productivity gains of this concept, the manning inputs to the model could be refined and the economies attributable to this policy change would increase.

HYBRID-ASSOCIATE AIRCREW AUGMENTATION

As an alternative to the transfer of aircraft from the active to the reserve forces, a policy of joint active/reserve aircrew manning

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*The recruiting budget probably could be trimmed as well.

†Including recruit trainee pay, subsistence, and travel expenditures.

Table 20

ESTIMATED ANNUAL NET SAVINGS FROM ARF GRADE RELIEF AND REDUCED BASIC TRAINING OF NONPRIOR-SERVICE RECRUITS

($ millions)

Type of Savings	USAFR	ANG	Total
ARF savings			
Recruit training (student cost)	14	17	31
Less the pay increase[a]	-5	-10	-15
ARF net savings	9	7	16
Air Training Command savings			10
Total net savings[b]			26

[a]Assumes 40 to 45 percent of reservist airmen are in authorized pay grades below E-5. Upgrading to E-5 raises their average pay by about 30 percent. Overall, the average airman base pay per man-day/drill is increased from $19 to $21.

[b]Savings do not include a possible reduction in recruiting costs.

could be developed. This approach to crew ratio augmentation with reserve crews is not new to the Air Force. The present associate concept in the strategic airlift fleet has been in successful operation for almost a decade. The associate units as presently constituted provide both reserve aircrews and maintenance and support augmentation. Other combinations are possible, and in this example we will analyze a rather simple active crew replacement scheme through the use of the FORCE cost model.

In contrast to the actual transfer of aircraft with the attendant realignments in force structure and support base, this case seeks to reduce the operating costs of the active squadrons by incorporating reservists into the organization. To estimate the cost implications of sharing aircrew manning with the ARF, we again employed a C-130 example. We exercised the model with the following design conditions:

- Reduction of the active crew to aircraft ratio from 2 to 1 on 12 C-130 squadrons equipped with a total of 192 aircraft.

- Augmentation of the active squadron strength with 192 reserve crews that fly at the programmed rate for ARF C-130 crews (about two-thirds of the rate of active crews).*
- Retention of the active force maintenance and support organization as is, with the manning designed to support wartime requirements implied by the crew ratio of 2.
- Assignment of the reserve aircrews to the current active units and provision of management support for them from the active force units.

Table 21 summarizes the results of the cost model run: Total annual savings of about $30 million are indicated for the hybrid-associate crew concept employed with 12 squadrons of C-130s, or $2.5 million per squadron. If this policy were applied throughout the active forces stationed in the CONUS, substantial savings could result, although aircraft with one-man crews and 1.25 crew ratios would have much less impact than our example produced.

This hybrid-associate concept could be expanded to substitute reservists for active duty aircraft maintenance personnel to the extent that the decreased peacetime flying rate reduced the need for full-time mechanics. The cost model also is capable of measuring the cost and manpower implications of other hybrid concepts, such as one reserve squadron being an integral part of each active wing.

The sampling of cost model runs described above indicates the great variety of resource estimates that can be calculated quickly and with relative ease by means of the FORCE cost model. We anticipate that this powerful and versatile computerized cost model will prove to be a valuable asset to Air Force planners in their continuing analysis of alternative force structures and operational concepts involving both active and reserve forces.

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*Most of the flying-hour differential stems from the "greening" of newly trained active aircrews. The input of the new crews might be reduced by this hybrid-associate concept, thus saving even more than is shown by our analysis. On the other hand, C-130s also support Army training, and that mission may require some ARF crew participation. The net effect of these requirements on total flying hours was not addressed in this example run.

Table 21

ANNUAL NET SAVINGS OF HYBRID-ASSOCIATE MIXED ACTIVE/ARF CREWS FOR 12 C-130 SQUADRONS

($ millions)

Planning Element	Active Force Savings	ARF Added Cost	Net Savings
Squadrons and BOS	$40	-$23[a]	$17
Depot maintenance	6	-4	2
Air Training Command			11
Total savings			30
Savings per squadron			2.5

[a] Reservist trainee costs of $1 million included in ARF squadron total.

V. SUMMARY AND CONCLUSIONS

As a part of the Total Force Options study we developed a consistent way to structure and cost active and reserve forces so that comparisons of the two would reflect their inherent cost differences. The process of making the ARF estimates consistent, conceptually, with active force practice involved the development of (1) ARF flying unit elements that were limited to the tactical organizations and the incremental support they require, and (2) a set of cost estimating relationships that included the expenditures incurred by the active establishment in support of ARF units and personnel. Individual squadron system cost comparisons were made of fighter and tactical airlift units to demonstrate this approach, and potential budgetary savings of about 30 percent were estimated for these reserve operations as contrasted with identically equipped active units.*

Still utilizing the individual squadron system cost approach for clarity, we then showed how the level of activity and the beddown--UE strength and base type--can exert a strong influence on the magnitude of these savings. We followed this discussion with a total force analysis, wherein we focused on force tradeoffs and policy options that have significant cost implications.

Using Rand's FORCE cost model, as modified for total force analysis, we gave some examples of policy options that might make the ARF more cost effective. These included:

- Minimal flying hours for the transition squadrons awaiting modern equipment.
- Reduction in the number of reservist support personnel collocated with the flying squadrons.
- ARF grade relief that would allow units to recruit prior-service E-5 applicants for openings that call for lesser ranks.

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*The question of the relative military *capability* is addressed in Ref. 2, Sec. V.

- A hybrid-associate concept that substitutes reservist crew members for one-half of MAC's 2.0 crew ratio for its C-130s.

Each of these policy options appears to save money. Even the grade relief proposal showed a net saving because the small increase in pay was more than offset by reductions in the training costs that were required for nonprior-service recruits in the base case.

We also ran some C-130 force transfer examples to observe the different levels of savings that would accompany ARF beddowns with squadron UE strength equivalent to the active practice, or with the more-prevalent "half-squadron" allocation. We then demonstrated how additional aircraft could be absorbed by the ARF without adding new squadrons by consolidating and augmenting the UE of several "underequipped" units. The greatest savings were achieved, however, by displacing--phasing out--older aircraft and replacing them with the newer aircraft. This would result in some loss of total force structure but its effect on our military capability would be difficult to measure--at least with some of the older aircraft models that now equip many of our reserve units.

As we pointed out in the analysis, the major portion of the savings that were achieved by these latter beddowns were, in reality, a cash-in of savings that could be realized *without any transfer* were it not for the policy of maintaining a constant 144 reserve flying squadron "floor." As long as this policy prevails, additional transfers from the active forces to the reserves could be accommodated by existing units with dramatic savings in the resources allocated to force operations.

A wide variety of total force issues was addressed in this study with the aid of the FORCE total force cost model. The capability of the model to produce relevant cost estimates in each case attests to its potential value as an analytical tool for evaluating total force mix alternatives and policy options.

APPENDIX

OVERVIEW OF FORCE, RAND'S TOTAL FORCE COST MODEL

This Appendix briefly describes Rand's total force computer cost model FORCE which was modified to perform reserve force calculations as a part of the Total Force Options study. The model is described in detail in Ref. 5. This Appendix attempts merely to summarize the model's structure and salient characteristics so that the reader can have some appreciation of the methods that were used to estimate the costs that appear in the main body of this report.

FORCE is a total force cost model, in contrast to one designed for the costing of individual force elements (e.g., A-7D squadrons) in isolation. Therefore, its data base contains all of the active and reserve weapon systems and support activities in the Air Force, to permit the interactions of a given force change to be traced throughout the entire military establishment. By means of the cost model estimating relationships, account can be taken of the effect on support organizations of changes in overall force size, equipment complexity, and various qualitative aspects of the force.

Unlike many force cost models that model flying unit system costs as building blocks, the FORCE cost model can compute the cost implications of "quality" changes such as flying hours per crew, variations in aircraft strengths, crew ratios, etc.--besides variations in the number of squadrons.

Base operating support, training, and other non-organic support activities are treated as separate elements in this cost model rather than as "indirect costs" of the force elements. Depot maintenance, for instance, is estimated weapon-system-by-weapon-system, on the basis of cost per UE aircraft and cost-per-flying-hour factors for the given aircraft types. The resultant depot costs, however, are displayed only as "below-the-line," informational costs at the aircraft planning element*

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*Planning elements are roughly equivalent to the program elements of the *F&FP*.

level; the cumulated total depot maintenance costs appear in separate depot maintenance elements--as they do in the *F&FP*. Base operating support, training (by type), medical, and other support activities similarly are derived on the basis of overall, total force considerations. The model computes costs and displays them in mission* form, rather than as isolated, individual force element building blocks. The cost of a change in force composition is the difference between the total force grand totals before and after the specified change.

Inputs take three general forms: (1) computer control, (2) data common to all units of the force (e.g., average pay and allowance factors), and (3) data tailored to specific planning elements (e.g., manpower per F-X squadron by personnel type, cost per flying hour). Separate formats and routines are available to enter and to manipulate data peculiar to specific types of units (e.g., aircraft, missiles, base operating support, reserve units).

Costs can be calculated and displayed over a period of up to 15 years, but a cutoff procedure allows fewer years to be projected if desired. Twenty-four personnel types are available to structure the manpower inputs.

To give some notion of the power and versatility of this force planning tool, a few of the routines are illustrated below. To avoid confusion from excessive detail, only the primary calculations are shown in the schematics and the examples are limited to a single year, a single personnel type, a single piece of equipment, etc.

Manpower can be input as number per squadron, number per UE aircraft, crew ratio, and maintenance man-hours per flying hour. A simplified schematic of one year's manpower calculations for an aircraft planning element is shown in Fig. 3. The blocks with cut corners represent data inputs, the circles give the form of the calculations, and the rectangles are the computed amounts. Solid lines trace the manpower calculations and the tracks show the steps needed to produce the cost estimates.

Tracing the interrelationships of the manpower estimating routine reveals that, for example, an increase in the number of UE aircraft

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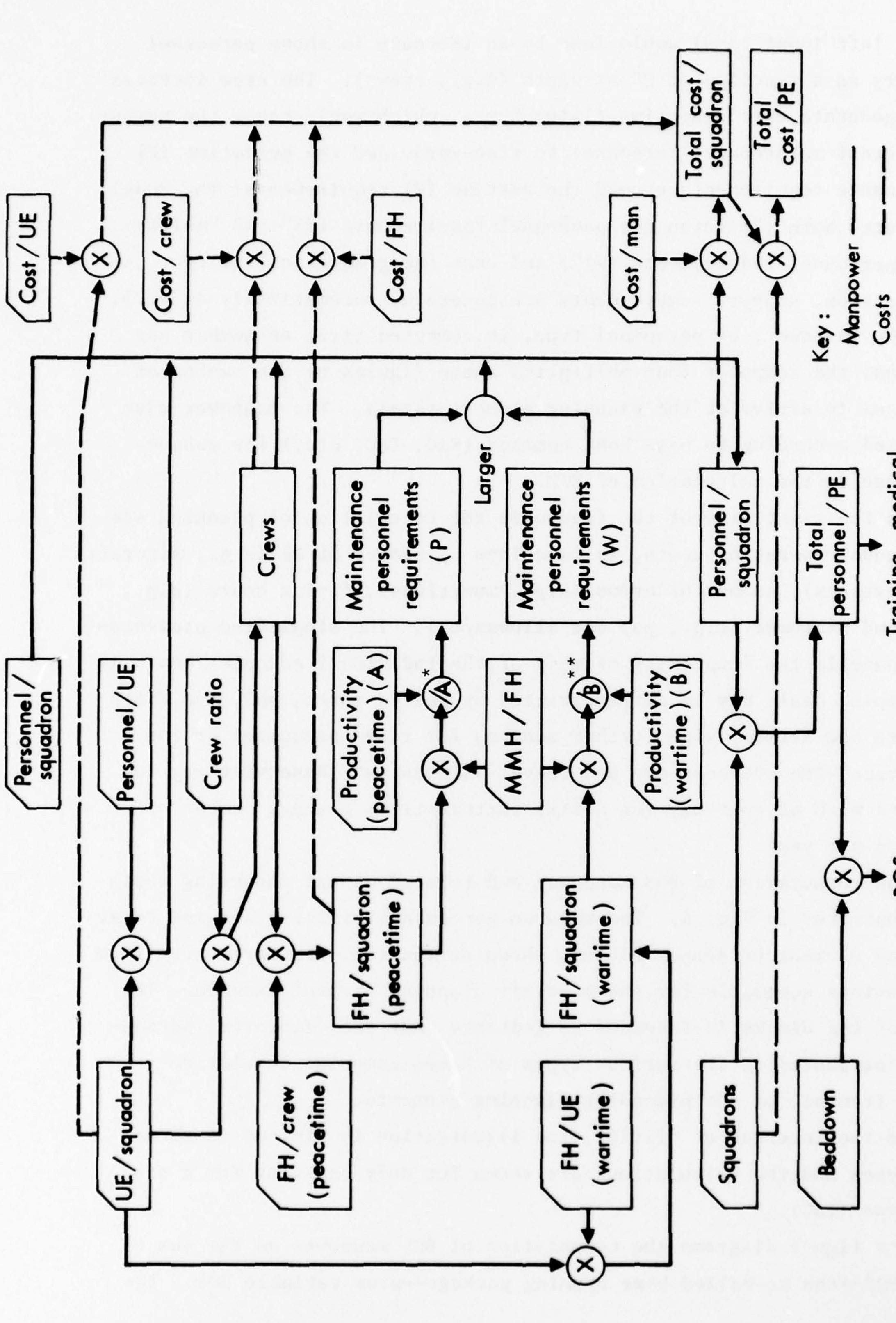
*Comparable to the *F&FP* programs.



* FH/squadron x MMH/FH ÷ Productivity (peacetime).

** FH/squadron x MMH/FH ÷ Productivity (wartime).

Fig. 3—Aircraft planning element personnel and recurring cost computations (simplified)

(upper left input card) would lead to an increase in those personnel who vary as a function of UE strength (e.g., crews). The crew increase would generate more peacetime flying hours, which would cause the number of aircraft maintenance personnel to rise--provided the peacetime (P) maintenance requirements exceed the wartime (W) requirements; the model calculates both ("maintenance personnel requirements (P)" and "maintenance personnel requirements (W)") and uses the greater of the two. As will be seen, support requirements are generated automatically as well.

The manpower, by personnel type, is computed first as number per squadron; the computer then multiplies these figures by the number of squadrons to arrive at the planning element totals. The manpower also is summed according to base host command (SAC, TAC, etc.) for subsequent use in the calculation of BOS.

On the right side of the figure is the calculation of planning element annual operating costs, as functions of number of UE (e.g., aircraft modifications), number of crews (e.g., munitions), flying hours (e.g., POL), and manpower (e.g., pay and allowances). The simplified presentation conceals the complexity of many of the individual calculations. As an example, basic pay is differentiated by active force, ANG, and USAFR officers and airmen, with further add-ons for rated personnel or for those receiving overseas pay and travel allowances. Reservist pay is computed with pay-per-day (or drill) factors times average number of man-days per year.

The computation of BOS manpower and related annual recurring costs is illustrated in Fig. 4. The beddown percentage distribution and total planning element personnel blocks, shown at the top, are carryovers from the previous schematic for the aircraft planning element example. The depth of the blocks is intended to indicate that the "supported personnel" distributed to the various types of bases comprise cumulative totals from all of the preceding planning elements.

In the interest of clarity, the illustration is limited to three base types and the calculations are shown for only one year for a single base type (TAC).

The figure diagrams the computation of BOS manpower as the sum of fixed BOS--the so-called base opening package--plus variable BOS. The

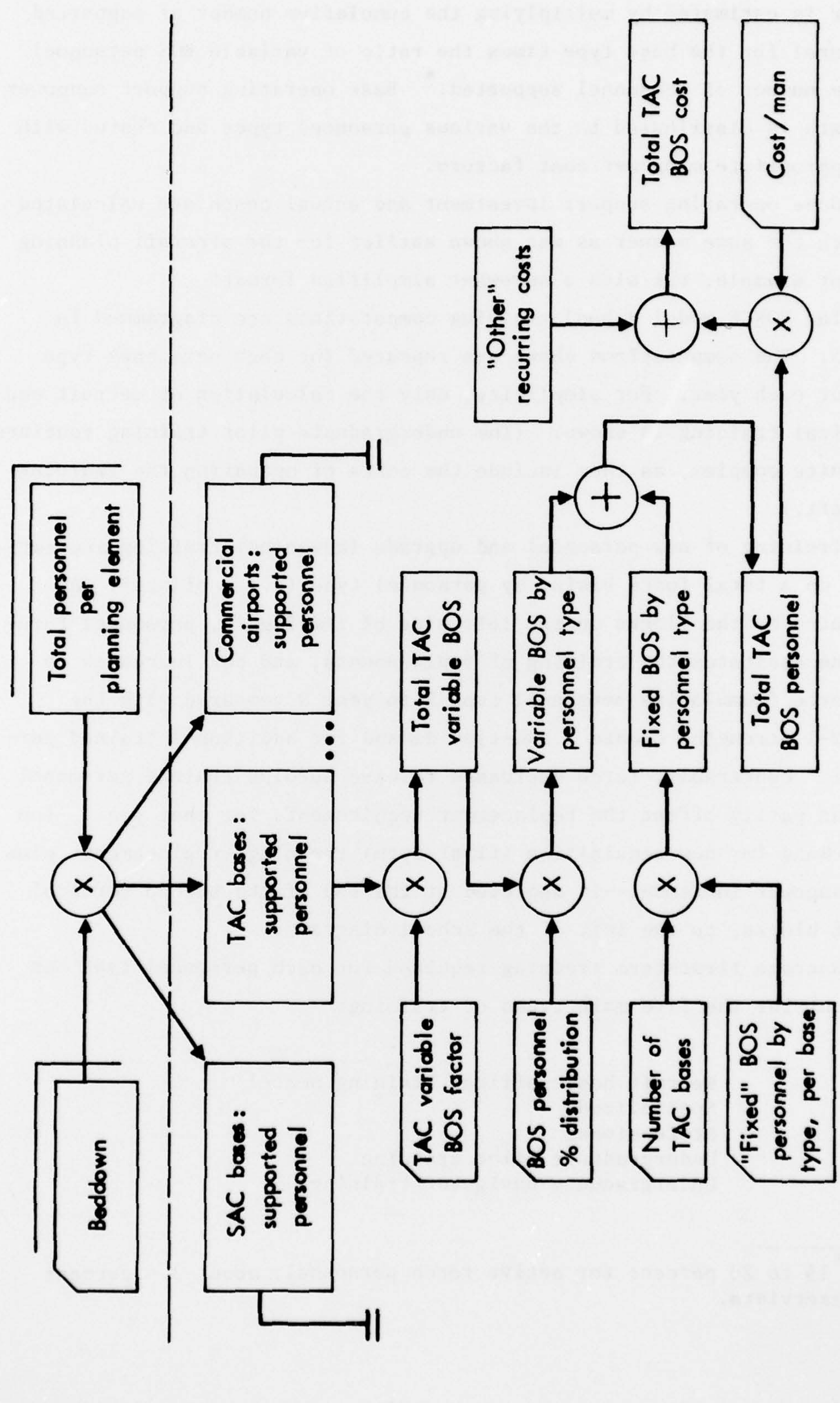


Fig. 4 — BOS personnel and recurring cost computations

latter is estimated by multiplying the cumulative number of supported personnel for the base type times the ratio of variable BOS personnel to the number of personnel supported.* Base operating support manpower strength is distributed to the various personnel types and costed with the appropriate manpower cost factors.

Base operating support investment and annual costs are calculated in much the same manner as was shown earlier for the aircraft planning element example, but with a somewhat simplified format.

The FORCE model school training computations are diagrammed in Fig. 5. The computations shown are repeated for each personnel type and for each year. For simplicity, only the calculation of recruit and technical training is shown. (The undergraduate pilot training routines are quite complex, as they include the costs of operating the training aircraft.)

Training of new personnel and upgrade (advanced) training are estimated on a total force basis, by personnel type (e.g., pilots). As indicated by the blocks on the left side of the figure, personnel turnover necessitates the training of replacements, and net increases in the force (cumulative personnel type X in year N compared with the year N-1 strength) create a one-time demand for additional trained personnel. Conversely, force decreases release surplus trained personnel who can partly offset the replacement requirements for that year. The net demand for new acquisition (first-term) training--replacements plus any manpower increment--is depicted at the top of the second vertical row of blocks, to the left of the school diagrams.

Average first-term training required for each personnel type can be input for the five main types of training:

Recruit basic/officer training school
Specialized
Professional
Undergraduate pilot training
Undergraduate navigator training

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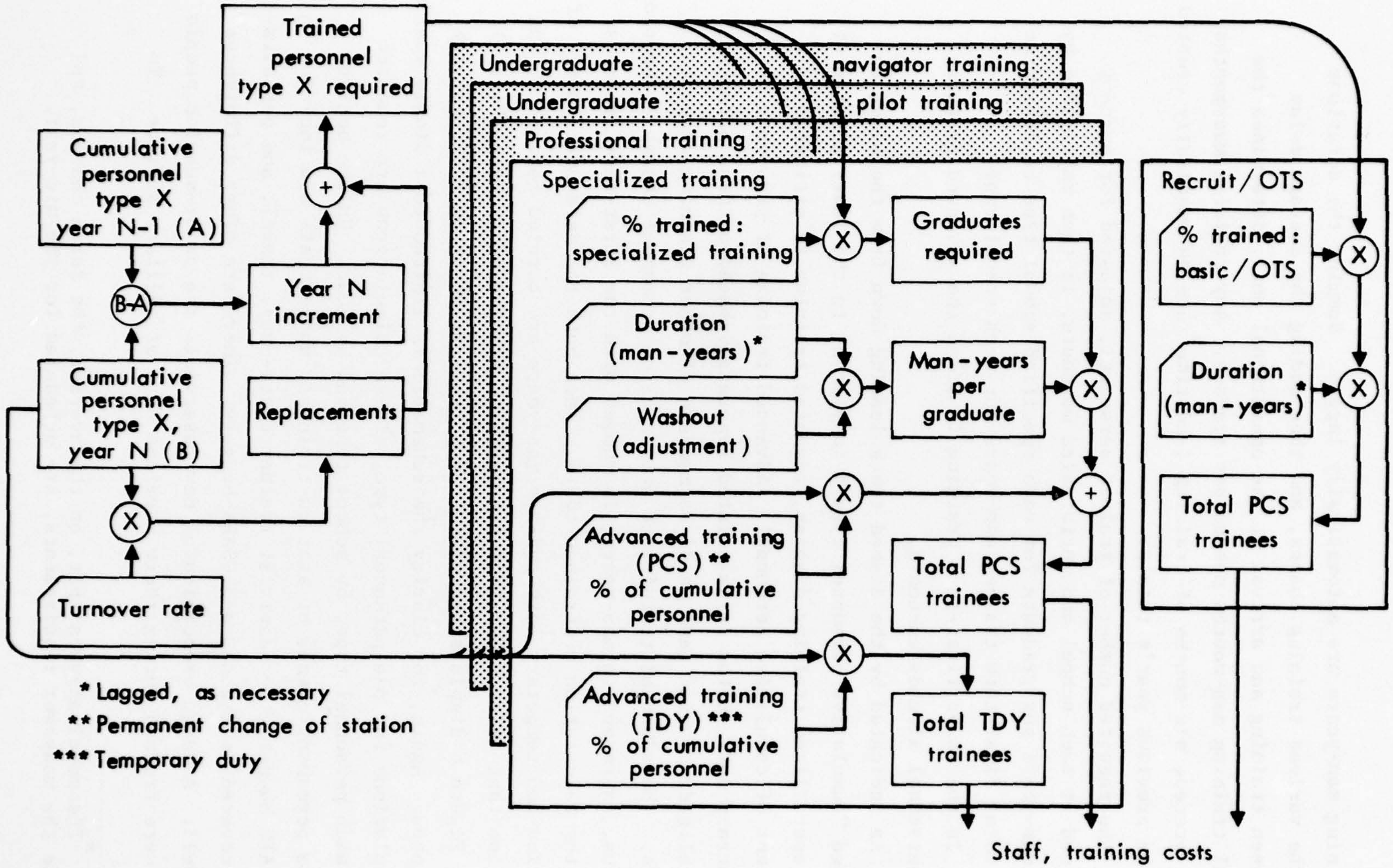
*15 to 20 percent for active force personnel; about 3.4 percent for reservists.



* Lagged, as necessary
** Permanent change of station
*** Temporary duty

Fig. 5—Training: computation of trainee man-years, personnel type X, year N

Training man-years are automatically lagged. Summing the durations of the various training phases, and then adding the average delay between training and arrival at the operational unit, determines the total training man-months needed per trainee. Any training man-months that precede six months of training lead-time* are automatically counted in the previous year's totals.

The required number of trained personnel, adjusted for percent trained at each school and anticipated washouts, is then multiplied by the man-years per graduate for each specified school type to determine the *total* first-term trainee man-years for each school type.

To the above first-term training is added the advanced training of personnel already on-board.

As indicated by the dashed track leading down from the block entitled "cumulative personnel type X in year N" to the lower portion of the specialized training diagram, advanced training is estimated as a percent of cumulative personnel. Advanced training of personnel on temporary duty status is calculated separately because these personnel are already counted (and paid) as members of other planning element units. The advanced training of personnel on permanent change of station status, expressed in man-years, is summed with the first-term trainees for the calculation of trainee costs. Then both the permanent change of station and temporary duty trainee man-years are carried forward to the routine that calculates staff requirements and training costs (Fig. 7).

Figure 6 displays the extra steps that are required for reservist trainees. Again, for clarity the schematic is limited to a single year's calculations for one personnel type. These calculations are repeated for each personnel type, by school type and by year. Unlike active force permanent change of station trainees, whose costs are included in the ATC budget, the reservist trainee costs--pay, travel, and per diem--are covered in the ANG and USAFR budgets. There are other differences as well: A large proportion of new reservists are prior-service people who were trained during their previous term of military service. To

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*The model assumes that, on the average, the force changes, and hence the manpower requirements, are scheduled for the mid-year.

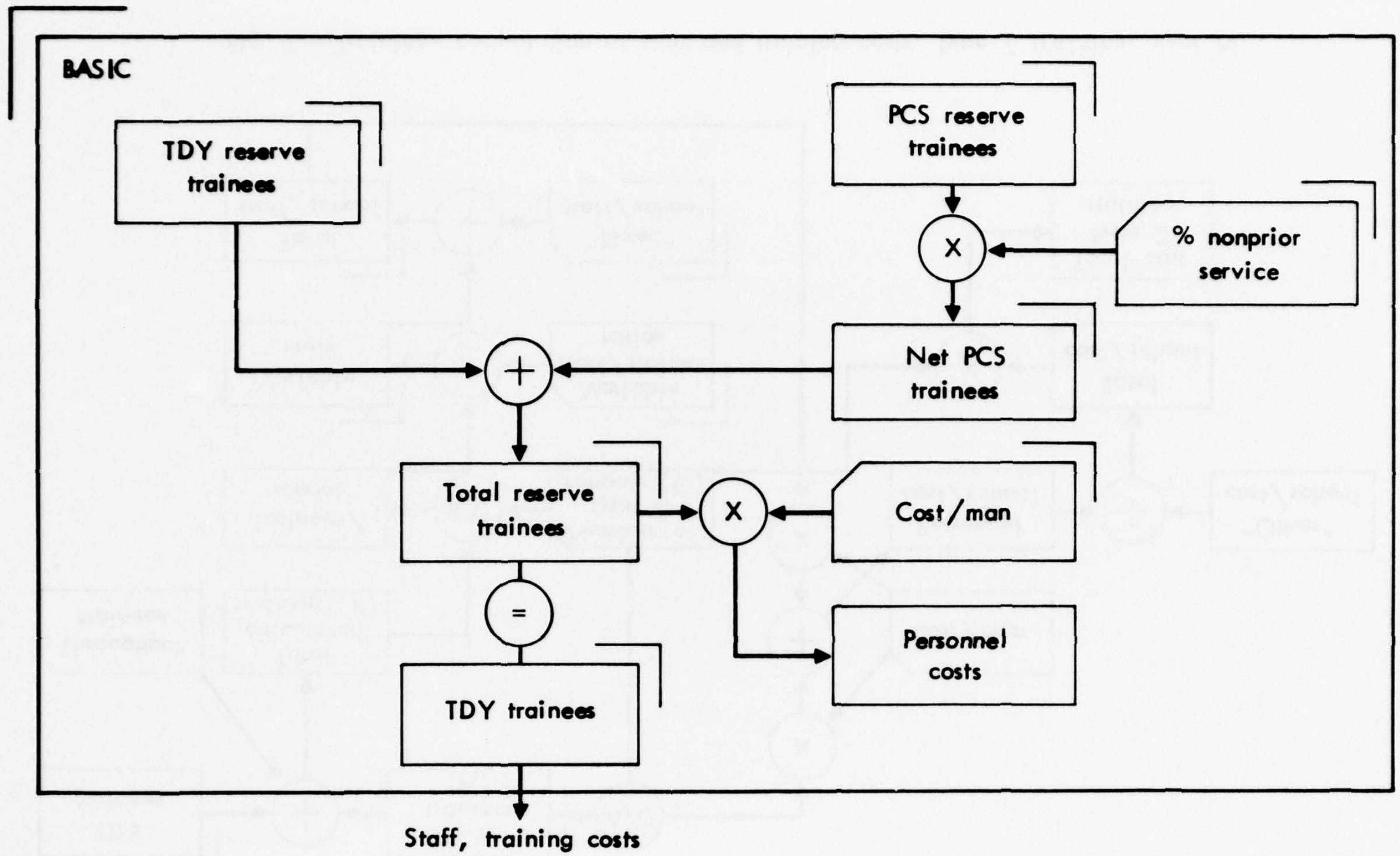

Fig. 6—Training: reservist trainee costs, by personnel type, by type of training

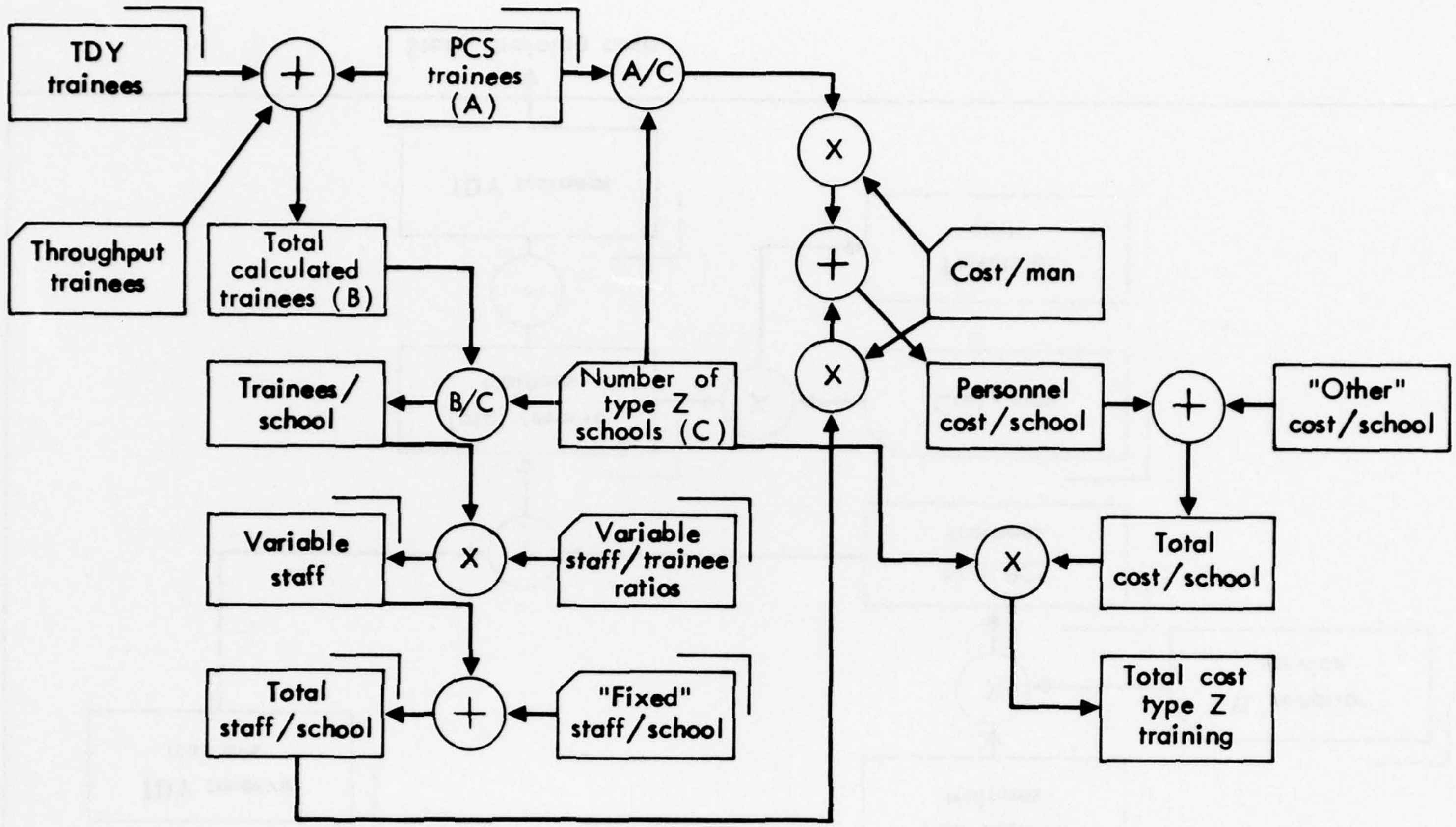

Fig. 7 — Training: computation of staff and training costs, type Z training, year N

adjust for this, the fraction of first-term (nonprior-service) reservists *to be trained* is input for each personnel type. These fractions can be varied for the out years to model the effect of changes in the availability of recruits with prior training. A further difference stems from the fact that reservists are paid by the day, and school training is additional to the normal unit training man-days. Additional pay, therefore, must be generated even for temporary duty training.

Figure 6 illustrates this special routine. The temporary duty and permanent change of station reserve trainee blocks shown at the top of the diagram are the outputs from Fig. 5. It should be noted that after the trainee pay is calculated, the reserve man-years are all converted to the "temporary duty" form so that they will not generate additional pay during the ATC school cost calculations.

The above reservist trainee man-years, together with the active duty trainee man-years shown as outputs in Fig. 5, are regrouped into total man-year trainee loads by school type for the calculation of school staff requirements and training costs. Figure 7 depicts one year's computations for a single school type.

The total number of trainees is divided by the appropriate number of training centers to put it in terms of the average trainee load per school. The staff is then calculated with staff to trainee ratios plus a fixed increment per school. The staff is distributed by personnel type and the costs of staff and permanent change of station trainees are estimated by means of the standard personnel cost factors. These are combined with the "other" training costs--POL, miscellaneous O&M, etc.--to measure the total cost per school. As the diagram indicates, the number of such schools is then recalled to produce total training costs for the given school type.

These calculations are repeated for each successive year, for each of the five school types.

Major equipment procurement can be input by means of a cost progress curve, or the costs per year can be computed outside the model and the results entered as throughputs. Figure 8 illustrates the progress curve approach. Given the cost of the first article and the assumed

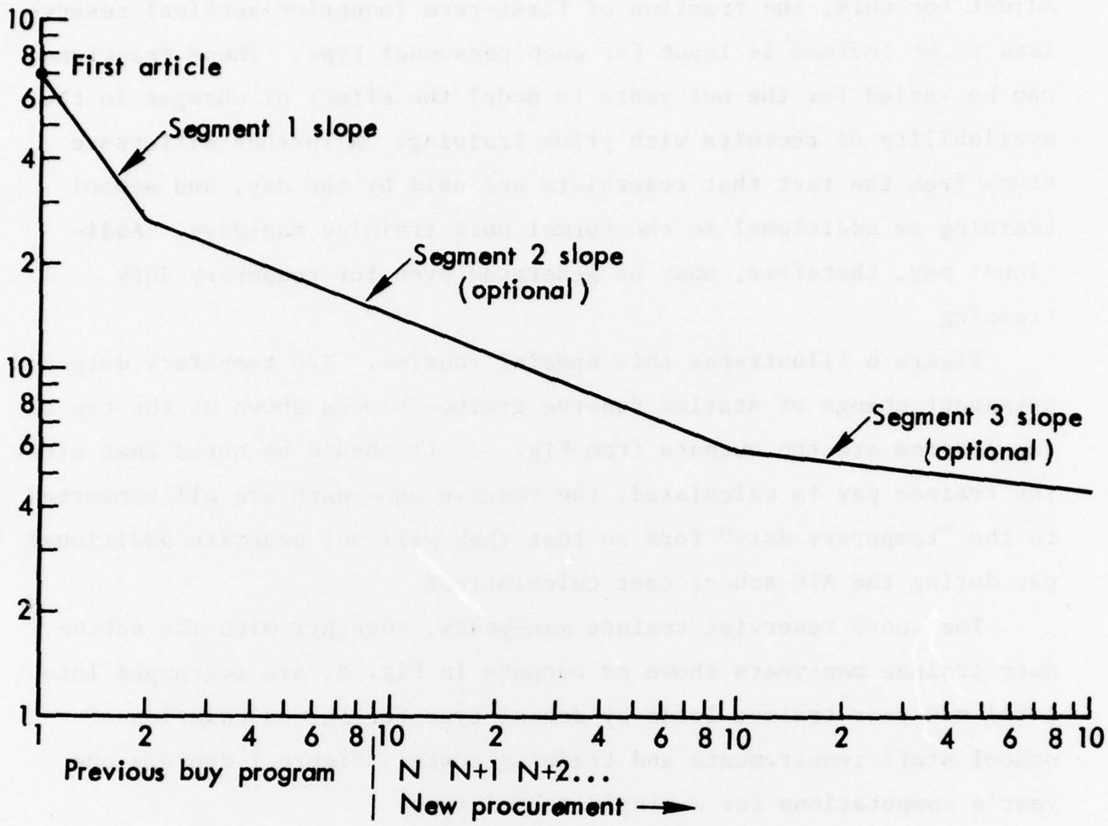

Fig. 8 — Equipment cost estimating routine

progress curve slope, the model will compute the year-by-year costs of the buy program. As the diagram indicates, the curve slope can be divided into as many as three segments if desired.

A delivery schedule determines the years in which the procurement costs will be recorded. A specific delivery schedule can be entered or, in the case of aircraft and missiles, the deliveries can be predicated on increases in UE. In the latter method, allowance can be made for additional equipment procurement to cover command support, attrition, etc. The model takes account of any prior procurement so that a given year's buy is calculated with the unit costs of the appropriate segment of the curve. It also allows for advanced buy and leadtime considerations. Initial support (peculiar support equipment and initial spares) can be computed as a cost per item or as a fraction of the cost per year.

Research and development inputs consist of the total R&D cost plus an annual funding pattern. The latter can be selected from nine common patterns and anchored to the system initial operational capability (IOC).

Construction costs for a given weapon system are influenced by the beddown and the existence of available facilities. For this reason, no automatic estimating equations are built into the model. Construction costs, if any, are calculated outside of the model and input in the form of throughputs for inclusion in the planning element and mission cost summations.

In addition to the more common estimating relationships that are programmed into the model for each planning element, the analyst has at his disposal a throughput/variable cost factor input that affords him the capability to estimate the value of any cost element of a given planning element by any of the following means:

- Year-by-year throughput
- Cost per squadron (or other unit designation)
- Cost per UE in the force structure
- Cost per flying hour (or other unit activity)
- Cost per active duty officer
- Cost per active duty airman
- Cost per civilian
- Cost per reserve officer
- Cost per reserve airman
- Cost per Air Technician.

These variables can be used singly or in combination.

Written statements, to enhance the comprehension of the inputs, calculations, or resultant manpower and cost totals (or for any other purpose), can be input along with the data cards for later display in the printout. Use of these messages is especially recommended when the analyst strays from the standard estimating procedures and makes use of the extremely flexible alternative cost derivations listed in the previous paragraph.

The brief overview of the FORCE cost model given here is intended only to provide the reader with a broad appreciation of the power and flexibility of the cost model used in the Total Force Options study. Further explanatory material is available in the Rand report cited earlier, Ref. 5.

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